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HISTORY

OF

THE IRON TRADE.

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HISTORY

OF

THE IRON TRADE,

FROM THE EARLIEST RECORDS TO THE PRESENT PERIOD.

BY

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"Audire est operæ pretium."

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PREFACE.

The writer was originally induced to collect facts relating to the History of the Iron Trade in the year 1826, when the quantity made in this country amounted to about 600,000 tons, in consequence of reading a petition to the Houses of Parliament in 1750 against a Bill for encouraging the Importation of Iron from our American Colonies. It was from "*the tanners of leather in and about the town of Sheffield in Yorkshire, representing that if the Bill should pass, the English iron would be undersold; consequently a great number of furnaces and forges would be discontinued; in that case the woods used for fuel would stand uncut, and the tanners be deprived of oak bark sufficient for the continuance and support of their occupation.*"

The extraordinary change from such a state of alarm on the part of the tanners, when the make of iron was about 17,000 tons, appeared a subject well worthy of consideration, taking into account the magnitude of the advantage to this country, in the abundant supply of this most valuable material, applicable to nearly all public and private uses; and

the trade, therefore, not only of this but of other countries was considered, and continued to 1840, when the make had increased to about 1,300,000 tons per annum, a result which, by comparison, appeared enormous. Since that time other engagements have withdrawn the Author's attention from the iron trade, at least so far as any continuation of the History was concerned; and a period has elapsed during which the make has further increased to about 2,700,000 tons! almost sinking into insignificance the make of 1840. This did certainly appear a matter of sufficient importance to justify an inquiry, —especially considering the striking events of the period which had elapsed,—as to the causes by which this enormous increase has been encouraged; whether to the advantage of individuals as well as of the country, and whether the supply is likely to be supported, or, on the contrary, whether reckless make has not brought as to a position from which, unless mineral fields, at present unknown, come into operation, with similar advantages to the black band ironstone of Scotland, we must retrograde, or as Mrs. Malaprop might say, "*begin to make our progress backwards*," and reduce the manufacture to somewhat more moderate limits.

There is no subject more important to the country than the success of the iron trade; and whatever cause may tend to affect a position to which we have once attained, it cannot but be a matter of general interest.

Liverpool, Sept. 1854.

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ERRATA.

Page 5., note, for "C. F. Sœrn" read "Wœrn."

314. line 1. for "Lord Dungannon" read "Lord Dundonald."

317. Declared Value of the Exports of British Iron and Steel, for "Tons" read "£"

HISTORY

OF

THE IRON TRADE.

INTRODUCTION.

In offering to the public a treatise, tracing the history of the rise and progress of the iron trade to its present state, the author ventures to believe that the importance of the subject, and the vast interest which this branch of our industry holds in general estimation, may lead to the conviction that such a work cannot be wholly unacceptable to any reader, but from its tenour, is calculated to be interesting in a mercantile and even national point of view. The design of the work is not to describe the various uses or manufactures of iron into instruments or machinery, but to report from researches into ancient and later writers, what they have noticed of importance relative to the history of iron, leaving opportunity and occasion for the author's remarks throughout the treatise,—an arrangement, which it is conceived will not be objectionable to any who may be disposed to allow this volume a place amongst books of reference.

The pursuit of information necessary for the establishment of matter of fact, and a desire to exclude irrelevant theory, have added to the labours of the author; and he has endea-

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voured so to condense as to offer, in one volume, the fruits of many years' investigation, hoping thus to have avoided prolixity without any sacrifice of the necessary explanatory details. The absence of any publication similar to this, and the scanty information to be gleaned from the scientific journals of this country, claim for this work at the hands of the public liberal consideration; and if criticism be disposed to severity, it should not be forgotten that a work of this character precludes the introduction of matter other than that which a close adherence to the subject renders admissible.

In speaking of this metal, Dr. Ure, in his "Dictionary of Arts, Manufactures," &c., thus expresses himself:—"Every person knows the manifold uses of this truly precious metal; it is capable of being cast in moulds of any form—of being drawn out into wires of any desired strength or fineness—of being extended into plates or sheets—of being bent in every direction—of being sharpened, hardened, and softened, at pleasure. Iron accommodates itself to all our wants, our desires, and even our caprices; it is equally serviceable to the arts, the sciences, to agriculture, and war; the same ore furnishes the sword, the ploughshare, the spring of a watch or of a carriage, the chisel, the chain, the anchor, the compass, the cannon, and the bomb. It is a medicine of much virtue, and the only metal friendly to the human frame. The ores of iron are scattered over the crust of the globe with a beneficent profusion, proportioned to the utility of the metal; they are found under every latitude and every zone, in every mineral formation, and are disseminated in every soil."

The increased value of manufactured iron, compared with the raw material, cannot, perhaps, be better illustrated than by taking as an example the price of Berlin cast-iron ornaments, which, in some cases, is equal to upwards of 55,000*l.* per ton, while the cost of the raw ore, from whence the article is manufactured, cannot be taken at more than thirty shillings per ton.*.

* From Dr. Friedenberg's German edition of Mr. Babbage's "Economy of Machinery and Manufactures."

In one of the principal manufactories of this description in Berlin, that of Devaranne, such is the fineness and delicacy of those separate arabesques, rosettes, medallions, &c., of which the larger ornaments are composed, that nearly ten thousand go to the pound, the price increasing in proportion to the fineness, as will be seen by the following table, which gives the selling prices at this establishment:—

	No. to the cwt.	Price of each article.	Price p. cwt. of the same.
1. Buckles, $3\frac{1}{2}$ inches long, and $2\frac{1}{2}$ inches broad	2640	£0 2 6	£330 0 0
2. Neck chains, 18 inches long, and 1 inch broad, and composed of 40 separate pieces	2310	0 6 0	693 0 0
3. Bracelets, 7 inches long, and 2 inches broad, and composed of 72 pieces pair	2090	0 8 6	888 5 0
4. Diadems, $7\frac{1}{4}$ inches high, and $5\frac{1}{4}$ inches broad - - - - - - -	1100	0 16 6	907 10 0
5. Sevigné needles, $2\frac{1}{2}$ inches long, and $1\frac{1}{2}$ inch broad, and composed of 11 parts	9020	0 4 6	202 10 0
6. Sevigné earrings, 3 inches long, and $\frac{7}{8}$ inch broad, and composed of 24 pieces - - - - - pair	10,450	0 5 3	2743 2 6
7. Shirt buttons - - - - -	88,440	0 8 0	2948 0 0

The articles written on the subject, which have appeared in "Rees's Cyclopædia" and in the "Supplement to the Encyclopædia Britannica," are confined exclusively to the history of our own manufacture, and were written (more particularly the former) when the trade was comparatively in its infancy. The interest excited, at the present time, by any allusion to the state or prospects of the trade, is fully proved by the ready transfer of papers touching on the subject, from the columns of one journal to another; these notices, however, barely extending beyond some statistical details over a confined period. Attention has lately been drawn to the progress perceptible in this manufacture in France, where the facilities are afforded for acquiring correct information as to the state of this branch of metallurgy; but still, without considerable research, little or no information can be obtained of the state of foreign manufacture in general. Without this information it is impossible to arrive at a satisfactory conclusion as to the

exact position in which we stand with regard to other countries; a species of information, which in itself would be peculiarly valuable at the present time, when all seem eager to increase to the utmost, and to take advantage of, the means placed at their disposal, by the inexhaustible mineral resources of this kingdom. The main object of this series of papers, next to the history of our own trade, is, then, to place in a clear and correct point of view the rise and progress of the trade in all countries where iron may be considered to be a staple manufacture.

It is proposed, in the following work, to trace the origin and use of the metal; the advance and improvements which have taken place; to consider the important question, how far the trade of this country is likely to be interfered with by foreign manufacture? and, at the same time, clearly to demonstrate the immense advantages we possess over other countries, and the improbability of their interference, to any extent sufficient to affect our permanent prosperity. The first chapter will show the early discovery of iron, the knowledge which the ancients had of this metal, and the purposes to which it was applied. The subsequent chapters will then trace the working of it in this country, from the time of the Romans to the almost total destruction of the manufacture, from the want of fuel, after the attempts to make coal available as a substitute for charcoal had failed, and note the progress and loss of the trade in Ireland, and the rise and history of the manufacture in the British colonies in America, up to the period of the war when they established their independence. Its history in Great Britain is then continued from the invention of the blast engine, the establishment of coal as fuel, and the introduction of certain valuable improvements in the manufacture of iron down to the year 1830, and previously to the further consideration of the home manufacture, the foreign trade is traced in its progress in each country separately, commencing with Spain.

Although the iron of Spain is of excellent quality, and probably more ductile than any other, it has never been a

manufacture of any extent, except at an early period, and then only in comparison with the confined rate of production of other countries. Not so Sweden and Russia: these countries are remarkable, not only for their extensive make*, but also for the superior quality of their iron; for many years we derived our principal supply from Sweden, till the rivalry of Russia interfered; and during the period in which, from want of fuel, our trade was at a stand still, we annually received many thousand tons from both these countries. Coal, the blast engine, and our local advantages, have, however, so completely superseded the use of foreign iron, that little or none is now imported, except for conversion into steel, and in this description of iron these nations are still without a rival —the finest steel iron used in this country being manufactured in Sweden, and some of the most useful, for particular purposes, in Russia.†

The histories of France and America open a wider field of inquiry, and are in every respect more virtually important to the iron manufacturing interests of this country. In the case of Sweden and Russia, a certain extent of make has been arrived at, beyond which it is not likely materially to advance. They supply almost exclusively their own wants, but the cost at which their iron is manufactured precludes the possibility of their entering into any extensive competition with our own in foreign markets. In the American alone can they venture to meet us, and there the competition arises from the heavy and unequal duties imposed by the States on our iron, in order to prevent its interfering with their own manufacture.

Both France and America uphold the monopoly of the raw material to the injury of all consumers, manufacturing as well as agricultural, and their shipping interests also severely feel

* For the recent returns of produce, principally of Sweden and Russia, the author is indebted to Mr. C. F. Sœrn, Junior, member of the Swedish Diet, who was kind enough to send him his "Treatise on the Repeal of Taxes on Iron in Sweden."

† A great change has, during the last few years, taken place affecting the use of Swedish iron in this country, which will be more particularly referred to in the chapter on Sweden.

the impolicy of this course of proceeding. An American writer thus comments upon the circumstance:—"We have wantonly sacrificed 'the comprehensive and permanent interests of the State to the particular and separate views of the counties or districts in which we reside.'"*

The baneful effect of individual interest operates to protect the monopoly in France. Messiers. Villiers and Bowring, in their "Report on the Commercial Relations between France and Great Britain," make the following observation:—"In France a very large proportion of those who are interested in the continuance of the existing commercial system, are elevated public functionaries, or are placed in immediate contact with them."†

The time is, however, near at hand when, in all probability, this exclusive system will be abolished, and our iron admitted in to both these countries at a moderate duty.

The interest and importance of this inquiry have induced the author to give at some length the history of the manufacture in France and America.

Belgium and the German States will close the inquiry into foreign manufacture.

The concluding chapters continue the history of the home manufacture from the year 1830 to the present time, with observations on the past and present state and prospects of the trade.

Since this Introduction was written, changes have taken

* Cambreleng's "Report to the Committee on the Commerce and Navigation of the United States."

† "Je ne connais de moyen d'animer un commerce quelconque, que la plus grande liberté et l'affranchissement de tous les droits que l'intérêt mal entendu du fisc a multipliés à l'excès sur toutes les espèces de marchandises, et en particulier sur la fabrication des fers.

"En général les dépenses d'exploitation sont si variables, si difficiles à prévoir, ont des proportions si différentes avec le produit réel des différentes mines, qu'une portion déterminée du produit, sans aucune déduction de dépenses, formerait nécessairement une taxe très inégale et d'autant plus injuste, qu'elle augmenterait à raison de la diminution des profits. Cette injustice existerait déjà, si ce dixième se prélevait sur la mine brute, sans avoir égard aux dépenses de l'extraction ; mais elle est encore bien augmentée par la disposition de quelques anciennes lois, qui règlent, que ce dixième sera pris sur les matières fondues et affinies, et qui par conséquent chargent encore l'entrepreneur de la dépense et des risques de la fonte."—TURGOT.

place in the duties, as will be shown in the following pages.

The public may refer to the various returns in this Book, with confidence, as they are altogether taken from official or otherwise authentic documents.

It has been the author's study to condense his subject as much as was consistent with the necessary detail and the interest of the narrative.

CHAPTER I.

EARLY PERIOD.

It may be necessary to premise this chapter by stating that, with the minute notice and a detail of the various iron ores and their location the author scarcely interferes, being well aware that that department more justly belongs to the practical geologist, from whose labours increasing information is constantly elicited, and rational conclusions are leading our views to the exalted origin of all knowledge. In the pursuit of scientific research, the utmost labour of the most enlightened, and the expanded ideas of the most learned philosopher, can reach but an atom of immeasurable omniscience. What then is the boast of human knowledge, the pride of man's learning? A few steps in the field, a few flowers gathered, from the ever-increasing myriads which nature presents everywhere to notice. How many vain attempts of our primitive fathers were essayed ere iron, the most plentiful and useful of all metals, was brought forth from the stubborn ores in which it was hidden! How zealous the daily and midnight endeavours of the alchemist to convert iron or stone into precious metals, or by a synthetical process to form gold! A recurrence to the curious records of such abortive labours may occasion a smile, grounded upon our advanced knowledge and experience. Which, of all the civilised nations of this refined age, is yet able to solve the problem of the formation or growth of metals? and to what human source may we, even in these times, turn for such information? Was there ever, since the creation of this globe, a time ere metals existed, when men might in vain have

explored the inmost recesses of the everlasting hills for the discovery? The answer to this is not less easy, perhaps, than that to the former question; both present a wide field for the maturest reflection, and give rise to a full consciousness of our feebleness; but more especially should it confirm us in humility. Science cannot yet unravel this mysterious growth or natural origin of iron, or the other metals. In our earliest and most authentic history (the Bible), we do not find a solution of the difficulty; but only know God created all things, and that by his almighty power they are continued.

It is a doubtful point, whether the dominion of man over the animal creation, or his acquiring the useful metals, has contributed most to extend his power. The era of this important discovery is unknown and very remote. It is only by tradition, or by digging up some rude instruments of our forefathers, that we learn that mankind were originally unacquainted with the use of metals, and endeavoured to supply the want of them by employing flints, shells, bones, and other hard substances, for the same purposes which metals serve among polished nations. Nature completes the formation of some metals. Gold, silver, and copper are found in their perfect state in the clefts of rocks, in the sides of mountains, or the channels of rivers. These were, accordingly, the metals first known and first applied to use; but iron, the most serviceable of all, and to which man is most indebted, is never discovered in its perfect form; its gross and stubborn ore must feel twice the force of fire, and go through two laborious processes, before it becomes fit for use. Man was long acquainted with the other metals before he acquired the art of fabricating iron, or attained such ingenuity as to perfect an invention to which he is indebted for those instruments wherewith he subdues the earth and commands all its inhabitants. In our present state, when we depend so greatly upon the use of iron and steel, it is difficult to conceive how man could exist in a state of society without their aid. From the Scriptures we learn that, but a short time after the Creation, Tubal-cain, a descendant of Cain, the son of

Adam, was "an instructor of every artificer in brass and iron."* And we find in the Sacred Volume, as the following quotations abundantly testify, singular evidence of the acquaintance which the Jews and other Asiatic nations had with the uses of metals. Mention is made of a land whose stones are iron; allusion is made to the furnace of iron. Vast numbers of chariots of iron are stated to have been employed by the Canaanites in their wars; and it is more than probable that those of Pharaoh, in his pursuit of the Israelites, were partly of that material (B. C. 1500). It is also said, that Og's bedstead was iron; and if we now descend the stream of time to David's era (B. C. 1044), plain mention is made of Goliah's iron spear-head, of saws, axes, and harrows of *iron*, of hammer and axe, of a rod of *iron*, bars of iron, of fetters of iron; in Job of barbed iron and fish-spears; and by Jeremiah of northern iron and steel, of yokes of iron, a pillar of iron, a pen of iron. Ezekiel (B. C. 590) speaks of a pan of iron, of trading with iron, of bright iron, &c., in thy market. It would be easy perhaps to largely increase the list of such notices in Sacred Writ; but we conceive this selection is amply adequate to the establishment of the fact, that the skill of those nations, in the working and forging of articles of well prepared iron, was continually exercised, and therefore that the art must have greatly advanced, and have become familiar to the people adjacent. Homer mentions a mass of iron as one of the prizes at the Funeral Games, given by Achilles in honour of Patroclus.†

> "Then hurl'd the hero, thundering on the ground,
> A mass of *iron* (an enormous round),
> Whose weight and size the circling Greeks admire,
> Rude from the furnace, and but shaped by fire.
> This mighty quoit Aëtion wont to rear,
> And from his whirling arm dismiss in air;
> The giant by Achilles slain, he stow'd
> Among his spoils this memorable load.
> For this he bids those nervous artists vie,
> That teach the disc to sound along the sky.

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* Gen. iv. 22.

† "Iliad," Book 23.

> Let him whose might can hurl this bowl arise,
> Who farthest hurls it, takes it as his prize:
> If he be one enrich'd with large domain
> Of downs for flocks and arable for grain,
> *Small stock of iron needs that man provide:*
> *His hinds and swains whole years shall be supplied*
> *From hence; nor ask the neighbouring city's aid,*
> *For ploughshares, wheels, and all the rural trade.*"

The ancient mythologists attributed the invention to Vulcan, the god of subterranean fire and metals, whom Sir Isaac Newton supposes to have been the same with Cinyras, king of Lemnos, an inventor of the art, who found out copper in Cyprus, the smith's hammer, anvil, and tongs, and employed workmen in making armour and other things in brass and iron. He was the only king celebrated in history for working in metals.

Herodotus says that a class of men, called *Curetes* (B.C. 1500), who were celebrated for their skill in the arts and sciences, were brought into Greece from Phœnicia, by Cadmus, son of Agenor, king of that country; some settled in Phrygia, and were called *Corybantes;* others in Crete, where they were called *Idæi Dactyli;* some in Rhodes, called *Telchines;* some in Samothrace, and were there called *Cabiri;* others in Eubœa, where, before the invention of iron, they worked in copper, in a city called Chalcis; some in Lemnos, where they assisted Vulcan; and some in Imbrus and other places. By the assistance of these artificers Cadmus discovered gold in the mountain Pangæus, in Thrace, and copper at Thebes; whence copper ore is still termed Cadmia.

In the countries where they settled, they first wrought in copper till iron was discovered, and then in iron; they made arms, and edged-tools for hewing and carving wood, which gave Minos, king of Crete (B. C. 1406), an opportunity of building a fleet and gaining dominion of the sea, and of establishing the trades of smiths and carpenters in Greece. A short time after, Dædalus and his nephew, Talus, invented the wedge, the saw, and the axe, the wimble, the perpendicular, and compasses, the turning lathe, glue, and potter's wheel, and many other mechanical instruments, and the sails

of ships; and Eupalamus invented the anchor; these were in the reign of Solomon. The invention of the art of fabricating iron by the Idæi Dactyli is, by Sir Isaac Newton, fixed at about B. C. 1035, which metal it is said, they discovered from the fusion of minerals at the accidental burning of the woods on the mountain Ida in Crete; others make it 400 years earlier. It seems, however, that the historians of antiquity have, in most cases, either attributed the discovery of metals to their gods, or they have deified those to whom mankind are so wholly indebted for having, by that means, been the founders of the present state of society.*

The early fame of Sidon, and afterwards its rival Tyre, for trading and riches, mark their civilisation; and these Phenicians, whose numerous vessels proclaim nautical knowledge, being a people from Asia, where iron was first discovered and used, lead to the conclusion that this busy nation taught their arts to other people.†

In the Trojan war, at the period when the pyramids of Egypt were built, B. C. 1186, the Tyrians seem to have navigated the Mediterranean to the pillars of Hercules, and shortly after the seas beyond, and their discovery of the British Isles was, it is supposed, about coeval with Nebuchadnezzar (Babylonian Captivity, B. C. 600).

The earliest writers on the manufacture of iron are Diodorus Siculus and Pliny the Elder; the former mentions the island of Æthalia (Elba) as abounding with ironstone, "which the natives dig and cut out of the ground to melt, in order for the making of iron; much of which metal is in this sort of stone. The workmen employed first cut the stone in

* Herodotus, book i. chap. 25. Beloe's Translation—Clio. (Glaucus, an inhabitant of Chios, invented the art of inlaying with iron.—Pausanias, book x.) He curiously inlaid a saucer of iron; it is of surprising workmanship, and as worthy of observation as any of the things preserved at Delphi. The name of the maker was Glaucus, an inhabitant of Chios, and the inventor of this art of inlaying iron; presented as an offering at Delphi, by Alyattes, the father of Crœsus, about 560 years before the Christian era.

† Solomon, when about to build the Temple at Jerusalem, solicited Hiram, king of Tyre, to send to him a man cunning to work in gold, and silver, and brass, and iron, and Hiram did accordingly.—2 Chron. ch. ii.

pieces, and then melt them in furnaces built and prepared for the purpose. In these furnaces the stones by the violent heat of the fire are melted into several pieces, in form like great sponges, which the merchants buy by truck and exchange of other wares, and export them to Dicæarchea and other mart towns.

"Some of these merchants that buy of these wares, cause them to be wrought by the coppersmiths, who beat and fashion them into all sorts of tools, instruments, and other shapes and fancies; some they neatly beat into the shape of birds, others into spades, hooks, and other sorts of utensils; all which are transported and carried about into several parts of the world by the merchants."

Pliny, in his Natural History, enters at much greater length into the account of the manufacture and general use of this metal than Diodorus, and the exceeding interest of his history, written in the early part of the first century, renders it peculiarly valuable to this work. After treating on other metals, he observes:—"It remaineth now, in the next place, to discourse of the mines of iron, a metal which we may well say is both the best and the worst implement used now in the world; for with the help of iron we break up and tear the ground; we plant and plot our groves; we set our vineyards and range our fruitful trees in rows; we prune our vines, and by cutting off the superfluous branches and dead wood, we make them every year to look fresh and young again. By means of iron and steel we build houses, hew quarries, and cut in stone; yea, and in one word, we use it to all other necessary uses of this life.

"Contrariwise, the same iron serveth for wars, murders, and robberies; not only to offend and strike therewith in hand, but also to reach and kill afar off, with divers sorts of darts and shot; one while discharged and sent out of engines, another while lanched and flung by the force of the arm; yea, and sometimes let fly with wings. This I take to be the wickedest invention that ever was devised by the head of man; for to the end that death may speed away the faster to a man and surprise him more suddenly, we make it to

fly as a bird in the air; and to the arrow headed at one end with deadly iron we set feathers at the other, whereby it is evident that the mischief proceeding from iron is not to be imputed to the nature of it, but to the unhappy wit of man.

"For good proof we had already by many experiments otherwise, that iron might be employed and occupied without any hurt or harm at all to mankind. And, verily, in those capitulations of peace, which, after the explusion of the kings, Porsena, king of the Tuscanes, tendered unto the people of Rome, I find this express article and imposition, that they should not use iron, but only about tillage of the ground. And as our chronicles of greatest antiquity have left recorded, it was not thought safe to permit writing and engraving letters with a style of iron. Certes, in the third consulship of Pompey the Great, by occasion of a tumult and commotion raised within the city of Rome, for the murder committed upon the person of P. Clodius, there was an edict came forth (which is now extant upon record), after this form:—'*Ne ullum telum in urbe esset.*'—'That no man throughout all Rome shall be seen to wear a weapon.' Nevertheless, men did not forbear and give over to do some honour unto iron, also in some other occasions of this life, tending to the entertaining of civility and humanity; for Aristonides, the cunning artificer, minding to represent in an image the furious rage of Athamas, beginning now to cool and be allayed, together with his repentance for the cruel murdering of his own son, Learchus, whom he flung headlong against the hard stones, and thereby dashed out his brains, made a temperature of brass and iron together, to the end that the rusty iron, appearing through the bright lustre of the brass, might express a blushing red in the countenance, beseeming a man confused and dismayed for so unnatural a fact. This statue is at this day to be seen at Thebes; within the same city there is another image of Hercules, all of hard iron or steel, which Alcon, the famous workman, made on purpose to signify the undaunted heart of that deified Hercules who underwent and endured all labours and perils whatsoever. Here also, in Rome, we may see certain

drinking-cups of steel, dedicated in the temple of Mars the Revenger.

"But to come unto the nature of iron, herein appeareth still the same goodness of Nature, that this metal, working such mischief as it doth, shall be revenged of itself, and receive condign punishment by its own rust. See also the wonderful providence of Nature, who maketh nothing in the world more subject to death and corruption than that which is most hurtful and deadly to mankind.

"As touching mines of iron ore, they are to be found almost in every country; for there is not so much as the island of Ilva (Elba) here within Italy, but it breedeth iron. And lightly wheresoever any such be, they are easily discovered, for the very leer of the earth, resembling the colour of ore, betrayeth where they lie; and when it is found out they burn, try, and fine it, as other veins of metal. Only in Cappadocia there is some question and doubt made, whether in the making of iron they be more beholden to the earth that yieldeth the ore, or to the water for the preparing and ordering of it. For this is certain that, unless the vein of ore be well drenched and soaked with the water of one river there, it will never yield iron out of the furnace.

"As for the kinds of iron, many there are, and all distinct. The first difference ariseth from the diversity of the soil and climate where the mines be found; for in some places the ground and the position of the heavens do yield only a soft ore, and coming nearer to the substance of lead than iron; in another the metal is brittle and short, standing much upon a vein of brass, such as will not serve one whit for stroke and nail to bind cart-wheels withal, which tire, indeed, should be made of the other, which is gentle and pliable. Moreover, some kind of iron there is that serveth only, if it be wrought in short and small works, as, namely, for nails, studs, and tacks employed about greaves and leg-harness; another, again, that is more apt to take rust and canker than the rest. Howbeit, all sorts of iron ore are termed in Latin *stricturæ,* a word appropriate to this metal and to no other—*a stringendâ acie,* 'of dazzling the eyes, or drawing a naked sword.'

"But the furnace itself where the ore or ironstone is tried, maketh the greatest difference that is; for therein you shall have to arise, by much burning and fining, the purest parts thereof, which, in Latin, is called *nucleus ferri*—'the kernel or heart of the iron' (and it is that which we call steel), and the same also of divers sorts; for the best is it that hardeneth the edge of any weapon or tool: there is of it which serveth better for stithy or anvil heads, the faces of hammers, bits of mattocks, and iron crows; but the most variety of iron cometh by the means of the water, wherein the iron, red-hot, is oft soon dipped and quenched for to be hardened. And, verily, water only, which in some place is better, in other worse, is that which hath ennobled many places for the excellent iron that cometh from them; as, namely, Bilbilis, in Spain, and Tarasco, Comum also in Italy; for none of these places have any iron mines of their own, and yet there is no talk but of the iron and steel that cometh from thence. Howbeit, as many kinds of iron as there be, none shall match in goodness the steel that cometh from the Seres; for this commodity also, as hardware as it is, they send and sell with their soft silks and fine furs. In a second degree of goodness may be placed the Parthian iron. And setting aside these two countries, I know not where there be any bars or gads tempered of fine and pure steel, indeed; for all the rest have a mixture of iron more or less; and, generally in the west parts of the world wherein we live, all our steel is of a more soft and gentle temperature than that of the Levant.

"This goodness of steel in some countries, ariseth from the nature of the mine, as in Austrich; in others, from the handling and temperature thereof, like as by quenching, as I said before, and, namely, at Sulmo, where the water serveth especially for that purpose; and no marvel, for we see a great difference in whetting and sharpening the edge of any instrument between oil whetstones that barbers use, and the common water grindstones, for surely the oil giveth a more fine and delicate edge. Furthermore, this is strange that, when the ore or vein is in the furnace, it yieldeth iron liquid and clear as water, and afterwards being reduced into bars and

gads, when it is red-hot, it is spongious and brittle, apt to break or resolve into flakes. And, considering the difference that is between the nature of oil and water, (as I have said), this is to be observed, that the finer any edge tools be, the manner is to quench them in oil for to harden the edge, for fear lest the water should harden them overmuch, and make the edge more ready to break out into nicks, than to bind and turn again. But, wonderful it is above all, that man's blood should have such a virtue in it, as to be revenged of the iron blade that shed it; for, being once imbrued therein, it is given ever after eftsoons to rust and canker.

"Concerning the loadstone and the great concord and amity between iron and it, I mean to write more amply in the due place. Howbeit, for the present thus much I must needs say, that iron is the only metal which receiveth strength from that stone—yea, and keepeth the same a long time, insomuch, as by virtue thereof, if it be once well touched and rubbed withal, it is able to take hold of other pieces of iron; and thus otherwhiles we may see a number of rings hanging together in manner of a chain, notwithstanding they be not linked and enclosed one within another. The ignorant people, seeing these rings thus rubbed with the loadstone, and cleaving one to another, call it quickiron. Certes, any wounds made by such a tool, are more eager and angry than by another. This stone is to be found in Biscay, scattered here and there in small pieces by way of bubbation (for that is the term they use); but it is not that true magnet or loadstone, indeed, which groweth in one continued rock; and I wot not whether these be so good for glass-makers, and serveth their turn so well in melting their glass as the other, for no man yet hath made any experiment thereof. But sure I am, that if one do rub the edge, back, or blade of a knife therewith, it doth impart an attractive virtue of iron thereunto, as well as the right magnet. And here I cannot choose but acquaint you with the singular invention of that great architect and master deviser, of Alexandria, in Egypt, Dinocrates*, who

* Dinocrates, an architect of Macedonia, who proposed to Alexander to cut Mount Athos in the form of a statue, holding a city in one hand, and in the

began to make the arched roof of the temple of Arsinoe all of magnet or this loadstone, to the end, that within that temple the statue of the said princess, made of iron, might seem to hang in the air by nothing—but prevented he was by death, before he could finish his work, like as King Ptolemy also, who ordained that temple to be built in the honour of the said Arsinoe, his sister.

"But to return again to our iron: of all mines that be, the vein of this metal is largest, and spreadeth itself into most lengths every way, as we may see in that part of Biscay that coasteth along the sea, and upon the ocean beneath, where there is a craggy mountain, very steep and high, which standeth all upon a mine or vein of iron. A wonderful thing, and in a manner incredible—howbeit, most true, according as I have showed already in my cosmography, as touching the circuit of the ocean.

"Iron made once hot in the fire, unless it be hardened with the hammer, dost soon waste and corrupt. So long as it looketh but red, it is not ready for the hammer, neither should it be beaten before it look white in the fire. Besmear it with vinegar and alum, it will look like copper or brass. If you be desirous to keep any iron-work from rust, give it a varnish with ceruse plaster and tar, incorporate all together, and this is that composition which is called, by the Greeks, antipathia. And some say that there is a kind of hallowing iron within the city, called Zeugma*, seated upon Euphrates, wherewith King Alexander the Great sometime bound and strengthened the bridge over the river there; the links whereof, as many as have been repaired and made new since, do gather rust, whereas the rest of the first making be all free therefrom." †

other a basin, into which all the waters of the mountain should empty themselves. This project Alexander rejected as too chimerical, but he employed the talents of the artist in building and beautifying Alexandria.—*Lempriere.*

* Zeugma, a town of Mesopotamia, on the western bank of the Euphrates, where was a well-known passage across the river. It was the eastern boundary of the Roman empire, and, in Pliny's age, a chain of iron was said to extend across it.—*Lempriere.*

† Pliny also mentions some hidden qualities of this metal, which must not be forgotten:—"As touching the use of iron and steel, in physic, it serveth otherwise than for to lance, cut, or dismember withal, for take a knife or dag-

Gibbon, speaking of the origin and monarchy of the TURKS in Asia, A. D. 545, says: —

"At the equal distance of two thousand miles from the Caspian, the Icy, the Chinese, and the Bengal seas, a ridge of mountains is conspicuous, the centre, and perhaps the summit of Asia; which, in the language of different nations, has been styled Imaus, and Caf, and Altai, and the Golden Mountains, and the Girdle of the Earth. The sides of the hills were productive of minerals; and the *iron forges* *, for the purpose of war, were exercised by the Turks, the most despised portion of the slaves of the Khan of the Geougen. But this servitude could only last till a leader, bold and eloquent, should arise, to persuade his countrymen that the same arms which they forged for their masters, might become, in their hands, the instruments of freedom and victory. They sallied from the mountains; a sceptre was the reward of his advice; and the annual ceremony, in which a piece of iron was heated in the fire, and a smith's hammer was successively handled by the prince and his nobles, recorded for ages the humble profession and rational pride of the Turkish nation."†

It appears, from these accounts, that iron was well known in the early ages, and applied to various useful purposes. The earliest method of working the furnaces where ores were smelted, seems to have been by exposing them to the wind — such was the practice of the Peruvians before the arrival of the Spaniards. From Alonso Barba we learn that their fur-

ger, and make an imaginary circle two or three times round, with the point thereof, upon a young child or an elder body, and then go round withal about the party as often, it is a singular preservation against all poisons, sorceries, or enchantments. Also to take any iron nail out of the coffin or sepulchre wherein man or woman lieth buried, and to stick the same fast to the lintel or side post of a door, leading either to the house or bed-chamber where any doth lie who is haunted with spirits in the night, he or she shall be delivered and secured from such fantastical illusions. Moreover, it is said, that if one be lightly pricked with point of sword or dagger, which hath been the death of a man, it is an excellent remedy against the pains of sides or breast, which come with sudden pricks or stiches."—*Dr. Holland's Translation.*

* The Turks offered iron for sale; yet the Roman ambassadors, with strange obstinacy, persisted in believing that it was all a trick, and that their country produced none.

† "Decline and Fall of the Roman Empire."

naces, called *guairas**, were built on eminences, where the air was freest; that they were perforated on all sides with holes, through which the air was driven in when the wind blew, which was the only time when the work could be carried on, and that under each hole was made a projection of the stone-work, on which was laid burning coals to heat the air before it entered the furnace.

Mungo Park, in his travels in Africa, mentions that, during his stay at Kamalia, there was a smelting furnace at a short distance from the hut where he lodged, and that he assisted the owner in breaking the ironstone. The furnace was a circular tower of clay, about ten feet in height, and three in diameter, surrounded in two places with withes, to prevent the clay from cracking and falling to pieces by the violence of the heat. Round the lower part, on a level with the ground, but not so low as the bottom of the furnace, which was somewhat concave, were made seven openings, into each of which were placed three tubes of clay, and the openings again plastered up in such a manner that no air could enter the furnace but through the tubes; by the opening and shutting of which the fire was regulated. These tubes were formed by plastering a mixture of clay and grass round a smooth roller of wood, which, as soon as the clay began to harden was withdrawn, and the tube left to dry in the sun.†

The ironstone he describes as very heavy, and of a dull red colour, with greyish specks; it was broken into pieces, about the size of a hen's egg: a bundle of dry wood was first put into the furnace, and covered with a considerable quantity of charcoal, which was brought ready burnt from the woods; over this was laid a stratum of ironstone and then another of charcoal, and so on until the furnace was quite full. The fire was applied through one of the tubes, and blown for

* To smelt the silver ore.

† "Dentila is famous for its iron; the flux used for smelting the iron is the ashes of the bark of the *kino* tree. These ashes are as white as flour: they are not used in dying blue, and must therefore have something peculiar in them. I tasted them: they did not appear to me to have so much alkali as the mimosa ashes, but had an austere taste. The people told me, if I ate them, I would certainly die."—M. Park, vol. ii. p. 65.

some time with bellows made of goats' skins. The operation went on very slowly at first, and it was some hours before the flame appeared above the furnace; but after this it burnt with great violence all the first night, and the people who attended put in at times more charcoal. On the day following the fire was not so fierce, and on the second night some of the tubes were withdrawn, and the air allowed to have free access to the furnace, but the heat was still very great, and a bluish flame rose some feet above the top of the furnace. On the third day, from the commencement of the operation, all the tubes were taken out, the ends of many of them being vitrified with the heat, but the metal was not removed until some days afterwards, when the whole was perfectly cool. Part of the furnace was then taken down, and the iron appeared in the form of a large irregular mass, with pieces of charcoal adhering to it. It was sonorous, and when any portion was broken off, the fracture exhibited a granulated appearance, like broken steel.

The owner informed him that many parts of this cake were useless, but still there was good iron enough to repay him for his trouble. This iron, or rather steel, is formed into various instruments, by being repeatedly heated in a forge, the heat of which is urged by a pair of double bellows, of a very simple construction, being made of two goats' skins, the tubes from which unite before they enter the forge, and supply a constant and very regular blast. The hammer, forceps, and anvil were all very simple, and the workmanship, particularly in the formation of knives and spears, was not destitute of merit. The iron he describes as hard and brittle, and that it requires much labour before it can be made to answer the purpose.

In the Himalaya Mountains, in Asia, iron is obtained by a smelting furnace of the following description: — It consists of a chimney, built of clay, about four feet and a half high, by fifteen to eighteen inches diameter, placed upon a stage of stone work, over a fire-place. In an opening below the stage there is a hole, through which the metal, when melted, flows, and this is stopped by clay or earth, easily removed by an

iron poker. The ore, which is black, but glittering with metallic lustre (like black ore of antimony) is mixed with charcoal pounded, and the chimney filled with the mixture, and, as it falls and consolidates, more is added from above.

The fire, once lighted, is kept alive by means of two pair of bellows, each made of a goat's skin, fixed in some way to the stone stage, and filled through apertures closed with valves, as ours are; a woman or boy sits between two of these skins, and raises and compresses them alternately with the hand; four such skins are thus applied to each chimney.

The method pursued in the two former instances is extremely simple, but, at the same time, very uncertain, whilst that employed in the latter presents a decided improvement, by the application of the bellows, which, although of no great power, yet, by affording a regular blast, renders the operation more certain, and the manufacturer independent of the weather.

We shall, in the following pages, see the, at first, gradual, and, subsequently, from the great improvements in machinery, very rapid steps by which this manufacture has been placed in its present leading station amongst the staple commodities of this and of other countries. The very high degree of perfection to which it has attained, has not only rendered it suitable to a variety of purposes, to which, until lately, it was not considered applicable, but has also rendered it an extensive article of exportation to every part of the world, and of the very first use and importance to the agricultural and manufacturing interests of our own country.

We cannot do better than conclude this introductory chapter in the words of Locke*:—"Of what consequence the discovery of one natural body, and its properties, may be to human life, the whole great continent of America is a convincing instance; whose ignorance in useful arts, and want of the greatest part of the conveniences of life, in a country that abounded with all sorts of natural plenty, I think may be attributed to their ignorance of what was to be found in a very ordinary despicable stone—I mean the mineral of iron.

* "Essay on the Human Understanding," book iv. chap. 12.

And whatever we may think of our parts or improvements in this part of the world, where knowledge and plenty seem to vie with each other, yet, to any one that will seriously reflect on it, I suppose, it will appear past doubt, that were the use of iron lost among us, we should in a few ages be unavoidably reduced to the wants and ignorance of the ancient savage Americans, whose natural endowments and provisions come no way short of those of the most flourishing and polite nations. So that he who first made known the use of that contemptible mineral, may be truly styled the Father of Arts, and Author of Plenty."

CHAP. II.

ENGLAND AND WALES.

HERODOTUS, who died about B. C. 414, tells us that "the Greeks knew the Phenicians fetched their tin from Britain." His remark establishes the fact of a trade of some standing; and can we suppose that the Britons during that intercourse, seeing the ships of their visitors, with all the usual requisites, iron arms and appointments, did not, even if before ignorant of iron and its uses, become fully instructed how to obtain it from its ores, and probably to form it into such things as they saw used, or as the Phenicians from accident or shipwreck might need to replace losses. More to confirm the preceding supposition, that the Britons knew and practised the manufacture of iron, we may remark, that Henry (in his Great Britain, vol. ii. p. 215., quoting Diod. Sic. lib. 5. sec. 22.) informs us that the Gauls were of the same origin, and spoke the same language as the ancient Britons, and that the Gaulish nations got possession of these coasts. It is unreasonable to suppose that a warlike nation should colonise Britain, and that the colonists should not bring with them their knowledge of iron and its uses in arms, &c., and at once labour to supply themselves. The Gauls were well skilled in mines. Strabo and Cæsar tell us in the Siege of Bourges, "they have great iron works, and every kind of mine."— See chap. x. on France.

The worship of Baal, apparent in the Druid worship, may originate from the Phenicians, and would seem to mark the intimate connection of the two people, and the consequent probability that they taught their arts also to the Britons. The Phenician exclusive trading with Britain appears to have lasted about 300 years, till interfered with by the

Greeks at about the time when Aristotle flourished (he *died* B. C. 322), and he speaks of the Britannic Isles. Pytheas, of Marseilles, 330 years B. C., seems the first of the Greeks who discovered the British Isles. That people speedily used the discovery, and commenced trading for tin, an article much in request both in Greece and Asia, and for which large dealings seem to have been carried on then, and previously for a long time by the Phenicians. This intercourse may have materially civilised the Britons, and have brought the nation to the degree of advancement it attained prior to the Roman invasion, which did not happen till after the lapse of about 250 years.

Polybius wrote, about 190 years B. C., a book now lost concerning Britain, and the management of tin there, a proof the Greeks traded there long before his day.— Henry, Great Britain, vol. ii. p. 209. The Syracusans certainly visited Britain up to B. C. 214, at which time they procured there and brought away a tree for a mainmast of the colossal ship of Archimedes.—Athen. Deipnos, lib. 5. c. 10.

The causes which operated to change the direct trading between the Greeks and Britons it seems difficult to determine, nevertheless they proved beneficial to the Gauls, through whose country, as we are informed (by Diod. Sic. l. 5. sec. 22. p. 347.), a vast trade of tin was conducted. The tin ingots were carried from Cornwall to the Isle of Wight, sold to the foreign merchants who resorted there, and by them were landed in Gaul, and taken overland in about a month to the mouth of the Rhone. The same writer states, "Those Britons (of the Land's-End, Cornwall), live in a very hospitable and polite manner, which is owing to their great intercourse with foreign merchants." Cæsar also states (De Bel. G. lib. 5. c. 13.), that before his time the trade of Britain being carried on by the Gauls, the greatest number of ships from the Continent came to the Kentish ports, whose inhabitants were the most polite and conversant with foreign merchants.

Thus a mass of evidence brings us to the certainty that in this so civilised state of the Britons, they had acquired or

previously knew the art of mining well; and that iron making and manufacture of arms were known and practised, it seems impossible to disbelieve. Henry (Great Britain, vol. ii. p. 136.) writes, "it is abundantly evident that our British ancestors had discovered or been taught the art of working tin, lead, brass, and *iron* before invaded by the Romans." The truth of this is confirmed by Strabo, who mentions that iron was one of the exports of Britain, as well as corn, cattle, gold, and silver. Lib. iv. p. 200.*

Having resolved to punish the Britons for assisting the Gauls in their wars with him, the difficulty which Cæsar found to obtain information relating to Britain, before he ventured to present himself and army as invaders, led him to the conclusion that the merchants and others were acquainted only with the neighbourhood of the sea-coasts, and country opposite to Gaul (as mentioned Cæs. de Bel. G. lib. iv. c. 20.); but it appears rash to adopt this inference, which his subsequent remarks seem not to justify. The jealousy of the Phenician traders in tin had, it may reasonably be inferred, descended to later merchants, and would render them also very silent when questioned as to the source of their profits, and the detail of British statistics. When, however, Cæsar tells us that the other parts of Britain were unknown by, and had no trade or intercourse with foreign nations, it is an assertion in some degree improbable, if we reflect on the variety and extent of the exports; and review his own subsequent remarks upon the military discipline, arms, and warlike opposition of the Britons to him; and also upon the knowledge and learning of the Druids, who sent the embassy to him after their knowledge of Volusenus' visit of observation, and Comius' return with those ambassadors. Cæsar's first invasion (55 B. C.) was vigorously opposed, and after much fighting, and other battles of almost doubtful issue, Cæsar granted a peace, and *in less than a month* from the day of his landing left Britain. His next expedition in the following spring arrived and

* Henry, Great Britain, vol. ii. p. 269. 5th edit., mentions that the Britons, at least a century before Cæsar's invasion, built small vessels, and exported their commodities to the Continent. Would not iron be employed here also ?

landed, unopposed, at the same point, five legions and 2000 horse; after some twelve hours, he found the British, who attacked his army, and were worsted. Next ensued the grand contest with Cassibelaunus, whose cavalry and chariots charged the Romans vigorously; further engagements occurred at the Thames, but the Romans prevailed. Cassibelaunus still retained 4000 war-chariots, and his military skill was very remarkable. These war-chariots were armed with scythes and hooks, for cutting and tearing: they were terrible to the Romans, and Cæsar's account of the great skill of the British in the use of them, shows the progress of that people in the art of war, as also does his detail of the arms of their cavalry, long shields, broad swords, and long spears. This rehearsal of the accounts of Cæsar's invasion is here given to show that Cæsar himself proves to us that the British were not so uncivilised, and points to the fallacy of the notion that the British then had iron only in such very small quantities, that it was consequently made into money* and ornamental articles. Cæsar's first stay was about three weeks; his second about four months†; in both which (his narrative shows) his constant care and attention were requisite to maintain his footing, and he never extended his personal inspection far into the country, not beyond Verulam.‡ Britain had for 500 years been, as we have seen, a trading

* "Utuntur aut æreo, aut talcis ferreis, ad certum pondus examinatis pro nummo." Cæsar de Bel. Gal. lib. v. c. 12. They use either brass, or iron rings, and plates of a certain weight, for money.

Gough's "Camden," 1789.—Translated from the edition of 1607.

P. 65. "I have already observed from Cæsar that the ancient Britons used brass money, or iron rings, or plates of a certain weight, and some persons pretend to have seen some of them found in urns."

Mr. Edward Lluyd, in his travels through Cornwall, sent in a letter to Thomas Tonkin, Esq., dated Falmouth, Nov. 29. 1700, the outlines of two iron plates, whereof several horse loads were found about six years before. He queries whether they might not be the British money mentioned by Cæsar, on which Mr. Tonkin, M. S. B., p. 193., remarks:—"I am apt to believe Mr. Lluyd concludes rightly," and then adds—"This present year, 1730, as they were pulling down the great tower, and some very old buildings, at Boconnoc, the seat of the late Lord Bohun, about a peck of the same sorts, but of larger size, were found in parts of an old wall there." Dr. Borlase engraved all these specimens in the second edition of his "Antiquities of Cornwall," p. 74.

† Cæsar quitted Britain, 26th Sept. 54 B.C.

‡ Strabo, lib. iv. p. 200.

country, visited by Phenicians, Greeks, Gauls, and probably by several other nations, many of which must have been in turn visited by Britons whose Druids (famed for learning originating from Asia), we find, taught useful arts to the people. We have seen that the Gauls and this people were skilled in war and mining, in trading and agriculture, and why not in the reduction of their abundant iron ores to a large extent for their own uses, and for export, as before shown from Strabo.

The articles of luxury, gold chains, drinking glasses, amber cups, which he also mentions as imported for the use of the Britons, would show advanced refinement among their princes.

We will now dismiss entirely this part of our subject, having, it is hoped, advanced proof that on comparing one part of Cæsar's narrative with others, we have elicited the truth, the only legitimate object of history.

The payment of tribute, which Julius Cæsar imposed on Britain, was never fully made, and Augustus did not enforce it except with threats (B. C. 25, to A. D. 12—21.), but some princes did give tribute and presents. In Tiberius's reign, he accepted what was given in the same way, and there seems to have been a good understanding. Caligula's insane, useless adventure and invasion, A. D. 40 (Suetonius, in Calig. c. 44.) needs here no other notice. At the invasion (in the reign of Claudius) commanded by Vespasian, A. D. 43, arts seem to have made great advances*, and we remark, that their progress was continual to the year A. D. 61, when Suetonius, with his small army of veterans, overcame all opposition, and gained his important victory over Queen Boadicea and her immense host. From this period the Romans appear to have retained possession of their dominion, and introduced, wherever they saw fit, the manufacture of such things as they needed. The seven campaigns of Agricola†, to A. D. 84, offer nothing in aid of our object than the knowledge of his unremitted attention

* Tacitus, Annal. lib. xiv. c. 33. London was at this time a great city of trade, and merchants, and shipping.

† Agricola lived six whole years in Britain, and visited every part.

to promote arts and civilisation everywhere, so stimulating the Britons to improve themselves.

The Emperor Adrian passed over into Britain in the year of our Lord 120, accompanied by the sixth legion; part of this body of troops was stationed at Bath, as may be inferred from two sepulchral *cippi*, discovered there some years since, commemorating an officer of this legion. During the year ensuing his arrival, the *fabrica*, or great military forge, was, probably by his directions, established at Bath. No other time is so likely for its erection as the interval during which Adrian remained in this country. These advantageous establishments had been lately introduced amongst the Romans, and different parts of the empire already had their *fabricæ*, from which immense utility was found to be derived. It is reasonable, therefore, to suppose, that an Emperor like Adrian, attentive to warlike affairs, skilled in tactics, versed in military discipline, passionately fond of his legions, ever desirous to promote their convenience, and assist their improvements, would transport into Britain, as early as possible, an establishment from which such numberless advantages had been produced on the Continent. Bath would be a spot of all others calculated for such an edifice; contiguous to the hills of Monmouthshire and Gloucestershire, where iron ore was found in the utmost plenty, and centrical in situation for the distribution of the arms, which were made at its furnaces, to every part of the kingdom.

The *fabrica* of which we are speaking was a college of armourers, where the various military weapons used by the Roman soldiers were manufactured. The business of this society, and the laws which regulated it, are developed by the Theodosian and Justinian codes. It there appears that, towards the commencement of the second century, the army smiths were created into companies, each governed by its own president or head, denominated the *primicerius*. That the employment of these bodies was to make arms for the use of the legion or legions to which it was attached, at public forges or shops, called *fabricæ*, erected in the camps, cities, towns, or military stations; that these arms, when forged,

were to be delivered to an officer appointed to receive them, who laid them up in arsenals for public service; that to prevent any abuse in this important branch of military economy, and to insure its proper and methodical management, no person was permitted to forge arms for the imperial service, unless he were previously admitted a member of the society of the Fabri; that, to secure the continuance of their labours after they had been instructed in the art, a certain yearly stipend was settled on each armourer, who (as well as his offspring) was prohibited from leaving the employ till he had attained the office of *primicerius;* and, finally, that no one might quit his business without detection, a mark or *stigma* was impressed upon the arm of each as soon as he became a member of the *fabrica.*

These colleges were of two sorts, the smaller and greater, the latter called, by way of excellence, *fabricæ sacræ.* Not attached to any particular legion, the *fabricæ sacræ* supplied whole provinces, and sometimes whole kingdoms, with military weapons. Of this kind the college at Bath is, with good reason, supposed to have been; furnishing arms not only to the garrison of the colony, but to the troops at Caerleon, Chester, and Ilchester, and to the whole army and line of stations throughout Britain, and to some bodies of Roman soldiers on the Continent. An establishment of this nature would add considerably to the consequence of Bath, which now became a scene of bustle and business. The road connecting it with the opposite side of the Severn was enlarged and repaired, as it supplied the forges with the iron manufactured at them, which, dug up in the Forest of Dean, and in the hills of Monmouthshire, was transported across the river at Lydney, landed at Aust, and brought to Bath by a military way, running nearly parallel with the upper Bristol road. The constant demand for military weapons from all parts of the kingdom gave an additional life and spirit to the city; its intercourse became general, and the roads which branched from it, in every direction, were crowded with vehicles that conveyed to different places the various destructive implements of war made at its *fabrica.*

The wise, vigilant, and accomplished Adrian, during his stay, was active and diligent in improving the people; from his time, his successors continued to work the iron mines, till the final abandonment of Britain, by the Romans, about A. D. 409.

Immense beds of iron cinders, relics of the Romans, have been discovered in the Forest of Dean, in Monmouthshire. Four miles north-west of Bolston Gaer, which lies near Miskin, the seat of William Bassett, Esq., under a large bed of cinders, a coin of Antoninus Pius was found in 1762, together with a piece of fine earthenware, charged with greyhounds, hares, &c., which the workmen broke to pieces. In Yorkshire, and other counties*, cinders have also been discovered accompanied with coins, all which evince the frequency of iron foundries during the period of the Roman reign in Britain.†

The Romans introduced iron foundries in Siluria, at Monmouth, Hadnock, Keven Pwlldu, and other parts of the country.‡ To the disturbed state of the country after the Romans left Britain, is to be attributed the suspension of the production of iron.

The conquest of Britain by the Saxons, a tedious and bloody era, seems to have been at first nearly destructive of all energy in the arts, and especially as relates to mines and making of iron; yet we cannot be surprised at the honour bestowed by the Anglo-Saxons, on artificers who excelled in fabricating swords, arms, and defensive armour (Wilkins, Leges Sax. p. 25.), all persons being required by law to have arms.

* Our iron mines were as well known to the Romans, as those of lead, as appears from an altar discovered at one of their walled towns, Condercum, or Benwell, inscribed to Jupiter Dolichenus, the deity who presided over this metal.—*Wallis's Nat. Hist. Northumberland*, vol. i. p. 118.

† Musgrave, in his "Belg. Brit." cap. xiii. sec. 4. says—"As regards iron, the best and worst instrument of life, it is manifest, that in the time of the ancients, it was produced in the country of the Silures (inhabitants of South Wales), and melted in furnaces, which the half burnt ashes to be seen in it at this day in great abundance, and the altar of Calpurnius, raised to Jupiter Dolichenus, as protector of iron works, in our time in a state of ruin, testify."

‡ Williams's History of Monmouthshire.

In the history of the five kings of England, from the union of the Heptarchy by Ecbert's conquest, we have sought unsuccessfully for information upon our subject.

The Danes having been at length subdued by Alfred, that excellent monarch, being at peace twelve years, did all he could to improve trade, naval power, and the arts, among his subjects; but we do not discover, either in this reign or in that of his son Edward or grandson Athelstan (who died, 941), any matter in aid of our history of iron.

The same may be also said of the succeeding seven reigns, to Canute the Great (18th king of England, who died, A. D. 1036), who, having subjected England, wisely resuscitated commerce and the arts. As no particular mention is made of iron, in this and the reigns of four succeeding monarchs to the conquest, it is uncertain to what extent the manufacture was carried on; but Camden states, that in and before the reign of William the Conqueror, the chief trade of the city of Gloucester was forging of iron; and it is mentioned in Doomsday book, that there was scarcely any other tribute required from that city, by the king, than certain dicars of iron, and iron bars, for the use of the royal navy. The quantity required was thirty-six dicars of iron—a dicar, containing ten bars, and one hundred iron rods for nails or bolts.

Giraldus Cambrensis, who lived in the twelfth century, says "the Forest of Dean amply supplies Gloucester with iron."

During the period from the Conquest to the death of John, iron and steel were imported into Britain from Germany and other countries; the "German merchants of the steel-yard" are thought by some to have derived that name from the great quantities of iron and steel which they imported, and sold at a place called the *steel-yard*. The art of making defensive armour was, during the same period, brought to such perfection, that a knight completely armed was almost invulnerable.

In the north of England mines were very rare*; there were so few in the reign of Edward the Third, that the governor of

* Holl. Chron.

Berwick-upon-Tweed, in the year 1376, was obliged to send for miners from the Forest of Dean, and the more southern parts, to assist him in retaking the town from the Scots. And in the tenth year of the preceding reign (Edward the Second), iron mines were so scarce, that the Scots, in a predatory expedition which they made in that year, met with no iron worth their notice until they came to Furness, in Lancashire, where they seized all the manufactured iron they could find, and carried it off with the greatest joy, though so heavy of carriage, and preferred it to all other plunder.

By an Act passed in the twenty-eighth year of Edward the Third, no iron manufactured in England, and also no iron imported and sold, could be carried out of the country, under the penalty of forfeiting double the quantity to the king; and the magistrates were empowered to regulate the selling price and to punish those who sold at too dear a rate, according to the extent of the transaction.

Although the art of forging iron had been so long, and so extensively in practice, there is no trace of the precise period at which the art of casting was discovered; in the year 1327, we hear of cannon, which are then supposed to have been first used in England, by Edward the Third, in his invasion of Scotland.

That fire-arms were used in France about the same time appears from the following article in the accounts of the Treasurer of War, A. D. 1338. "To Henry de Faumichan, for gunpowder and other things necessary for the cannon, at the siege of Puii Guillaume."*

Edward the Third had cannon with his army at the famous battle of Cressy, and still more famous siege of Calais, in the year 1346.

The illustrious Petrarch, in one of his dialogues on the remedies of good and bad fortune, which were written A. D. 1358, speaks of cannon as a comparatively new invention.—

"G.—I have cross-bows, and other machines of war.

"R.—I am surprised that you have not also some of those instruments which discharge balls of metal with most tremen-

* Henry's Great Brit.

dous noise, and flashes of fire. These destructive plagues were, a few years ago, very rare, and were viewed with the greatest astonishment and admiration, but now they are become as common and familiar as any other kind of arms. So quick and ingenious are the minds of men in learning the most pernicious arts."

Cannon, or, as they were then called, *bombards*, were all made of iron, until about the middle of the fifteenth century, when a mixed metal called font-metal, or bronze, was invented. In 1378, Richard the Second gave a commission to Thomas Norwich, to buy two great and two small cannon in London, or any other place. Besides great guns, a smaller kind of fire-arms, called "hand-cannon," came into use at this time. They were so small and light, that one of them was carried by two men, and fired from a rest fixed in the ground. The 400 cannon, or the greatest part of them, with which an English army besieged St. Malo, in 1378, must have been of this kind.

During the fourteenth and fifteenth centuries, iron and steel were imported from Germany, Prussia, and other places, and also iron from Spain. But as several improvements in the manufactures had taken place in the course of this period in England, laws were made towards the end of it, against importing any of the articles manufactured in this country in iron and steel. Upon a petition to the House of Commons, A. D. 1483, from the manufacturers of London and other towns, representing the great damage they sustained by the importation of the articles which they manufactured, an Act was passed against the importation of knives, hangers, tailors' shears, scissors and irons, fire-forks, gridirons, stock-locks, keys, hinges and garnets, spurs, bits, stirrups, buckler-chains, latten-nails with iron shanks, buckles for shoes, shears, ironwire, iron candlesticks, grates, and other articles of home production.

We are without any particular information respecting the progress made in the manufacture of iron, until the reigns of Elizabeth and James the First; there is no doubt, however, of the works having materially increased in many parts of the

country, and particularly in Sussex. We learn from Leland, speaking of the Forest of Dean, that "the ground is fruitful of iron mines, and divers forges there to make iron;" also, in Somersetshire, "iron ore found of late at Mendip, and iron made there." In Camden, we find "Sussex is full of iron mines everywhere, for the casting of which there are furnaces up and down the country, and abundance of wood is yearly spent; many streams of water are drawn into one channel, and a great deal of meadow ground is turned into pools, for the driving of mills by the flashes, which, beating with hammers upon the iron, fill the neighbourhood night and day with their noise. But the iron here wrought is not everywhere of the same goodness, and, in general, more brittle than Spanish iron. It yields, however, no small profit to the proprietors of the mines, who cast cannon, and other articles in it." He also mentions Yorkshire and Staffordshire — of the former, "Sheffield, remarkable among many other places hereabouts, for blacksmiths, there being much iron digged up in these parts;" of the latter — "the south, which has much pit-coal and mines of iron, but whether more to their loss or advantage, the natives themselves are the best judges, and so I refer it to them."

In 1558 an Act was passed that timber should not be felled to make coals for burning iron. It was enacted that no timber, of the breadth of one foot square at the stub, and growing within fourteen miles of the sea, or of any part of the rivers of Thames, Severn, or any other river, creek, or stream, by the which carriage is commonly used by boat, or other vessel, to any part of the sea, shall be converted to coal, or fuel, for the making of iron. This Act not to extend to the county of Sussex, nor to the weald of Kent, nor to any of the parishes of Charldwood, Newdigate, and high in the weald of the county of Surrey. — 1 *Eliz. c.* 15.*

* Iron wire, in England, was, before 1568, all made and drawn by main strength alone. In the Forest of Dean, and elsewhere, the Germans then introduced the art of drawing it by a mill. The greatest part of the iron wire, and ready-made wool cards, had been hitherto imported. — *Gough's Camden* (additions).

The iron and wire works, near Abbey Tintern, were erected by Germans. — *D. Williams's History of Monmouthshire.*

In 1581 a further Act was passed, to prevent the destruction of timber, setting forth that, by reason of the late erection of sundry iron-mills, in divers places of this realm, not far distant from the city of London, and the suburbs of the same, or from the downs and sea-coasts of Sussex, the necessary provision of wood, as well timber fit for building, and other uses, as also all other fellable wood serving for fuel, doth daily decay and become scant, and will in time to come become much more scarce, by reason whereof the prices are grown to be very great and unreasonable. For remedy whereof, it was enacted, that no new iron-works should be erected within twenty-two miles of London, nor within fourteen miles of the river Thames, nor in the several parts of Sussex near the sea therein named, neither should any wood within the limits described, be converted to coal, or other fuel for making of iron. — This Act not to extend to the woods of Christopher Darrell, in the parish of Newdigate, within the weald of Surrey, which woods have been, and are preserved and coppiced by him, for the use of his iron-works in those parts. — 23 *Eliz. c.* 5.

A subsequent Act prohibited the erection of any new iron-works in Surrey, Kent, and Sussex, and ordered that no timber, of the size of one foot square at the stub, should be used as fuel at any iron-work. — 27 *Eliz. c.* 19.* †

* Godfrey Box, of Liege, set up at Dartford, in the year 1590, the first iron mill for slitting bars.—*Gough's Camden* (additions).

† In the Stradling Correspondence, edited by the Rev. J. Montgomery Traherne, we find the following letter on the scarcity of iron in Glamorganshire in the reign of Queen Elizabeth, 1586.

" *To the right wor. my very good cosen Sr. Edwarde Stradling, Knighte.*

" Sr., I am entreated by Robert Hensley, the bearer herof, to enforme you of the troeth of a bargayne betwine him and one Thomas Sulley, late of St. Athens of yor neere neighbourhoode, touchinge an anvyle wch he did sett unto the sayd Sulley for a yere. The bargayne is witnessed by two p'sons, viz. John Wattes, clerke, minister of Porlocke, and John Bearde of Selworthye, who sayeth that, about our Lady-day last past, Robt. Hensley did sett to heire the sayd anvyle to the sayd Thomas Sulley at a rent of iiis. iiii*d.* for the yere; with further condicon that yf the sayd Robert, or any of his brothers, woulde require to have agayne the sayd anvyll into theire possession wthin the sayd yere, then, upon one qrter's warninge, the sayde anvyle was to be restored, and he to abate of the rente according to the tyme that he possessed the same. The ptyes yt dothe testifie this bargayne are honest and credible; wherfore

The scarcity of fuel for the iron-works being now severely felt, persons interested in the manufacture naturally turned their attention to the subject, with a view to find a substitute. if possible, for that fuel of which they had been deprived; and attempts were made by many persons, in the reigns of James the First and Charles the First, to smelt iron with pit-coal, but without success; and, consequently, the iron-works in many parts of the country were stopped entirely, and in other parts materially decreased.

The following account, taken from the *Metallum Martis*, of Dudley, published in the reign of Charles the Second, gives a full and interesting history of his own various experiments for the smelting of iron with pit-coal. It commences with an epistolatory dedication to the king, which is followed by a long prefatory epistle to parliament, wherein, amongst other information, petitions, &c., he says:—

"My dear Master,—Our sacred martyr, Charles the First of ever blessed memory, did animate the author, by granting him a patent in the fourteenth year of his reign, for the making of iron, and melting, extracting, refining, &c., all minerals and metals with pit-coal, sea-coal, peat, and turf, which was extinct, and obstructed by this unnatural and unparalleled war." This concluded with a letter:

"To the reader, especially of England, Scotland, and Wales:

"The injury and prejudice done unto me, and to this island, my native country, for the making of iron with pit-coal, &c., moved me, in the negligence of better wits and pens, to apologise for it in the ensuing treatise; and believe me, reader, it was no private or political design in my invention,

I beseech yow extend yor lawfull favor to my honeste countreyman accordinge to the equitye of his cause: so shall you have me ever ready to requite you or any neighbour of yors in the like cause, or greater, as occasion shall move.

"Thus, making to you and to my good ladye my right harty comendacons, doe take my leave of you.

"Att my house, Combsydenham, this xxixth of June 1586.

"Yor very loving frend and cosen,

"George Sydnaham."

but mere zeal, becoming an honest man, *Patriæ, parentibus, et amicis*, that engaged me, after many others failed in these inventions, for the general good, and preservation of wood and timber, which,

> Æque pauperibus locupletibusque,
> Æque neglectis pueris senibusque nocebit.

"DUD. DUDLEY."

He then proceeds:—"Having former knowledge and delight in iron-works of my father's, when I was but a youth, afterward, at twenty years old, was I fetched from Oxford, then of Baliol College, *anno* 1619, to look over and manage three iron-works of my father's, one furnace, and two forges, in the chase of Pensnet, in Worcestershire; but, wood and charcoal growing very scanty, and pit-coals, in great quantities, abounding near the furnace, did induce me to alter my furnace, and to attempt, by my new invention, the making of iron with pit-coal, assuring myself, in my invention, the loss to me could not be greater than others, nor so great, although my success should be fruitless; but I found such success at first trial as animated me, for, at my trial, or blast, I made iron to profit with pit-coal, and found *facere est addere inventioni.* After I had proved by a second blast and trial, the feasibility of making iron with pit-coal and sea-coal, I found by my new invention the quality to be good and profitable, but the quantity did not exceed above three tons per week, though I doubted not in future to have advanced my invention to make quantity also.

"Immediately after my second trial, I wrote to my father what I had done, and, withal, desired him to obtain a patent for it from King James, of blessed memory; the answer to which letter I shall insert, only to show the forwardness of King James, in this his much animating the invention, as did others—

"'SON DUDLEY,—The King's Majesty being at Newmarket, I sent Parkes thither on Saturday, to some friends of mine, to move the King's Majesty for my patent; which he, coming on Sunday morning, in the afternoon his Majesty sent

a warrant to Master Attorney to dispatch my patent, for the which I am infinitely bound unto his Majesty, that it pleased him, of his great grace and favour to dispatch it so soon. I have been this night with Master Attorney, who will make haste for me. God bless you, and commend me unto all my friends.

"'Your loving father,

"'EDWARD DUDLEY.'

"This Richard Parkes, of Parkhouse, Esquire, in the letter before-mentioned, was the author's brother-in-law, which did about one year after the patent was granted, carry from the author much good merchantable iron unto the Tower, by King James' command, to be tried by all artists, who did very well approve of the iron; and the said Parkhouse had a fowling gun there, made of pit-coal iron, with his name gilt upon the gun, which gun was taken from him by Colonel Leveson, Governor of Dudley Castle, and never restored.

"The said Richard Parkhouse's son, my nephew, Edward Parkhouse, the 5th January, 1644, pressed me much to put pen unto paper to what I have done in the invention of making iron with pit-coal and sea-coal, not unknown unto this country, and to my brother Folliott, Esquire, and my nephew Parkhouse, Esquire, and to my kinsman, Master Francis Dingby, to whom I intend to leave the secrets of my inventions. Notwithstanding all my sad sufferings from time to time, these forty years, in the inventions, my sufferings in the war, and my estate sold for my loyalty, and also my sad sufferings and obstructions since his Sacred Majesty's happy restoration, many ways; and also upon sundry and many references, at the author's very great charge, pains and time spent, of four years, in his aged days, for the general good, by his invention for the preservation of Great Britain's wood and timber. Now, let me show some reasons that induced me to undertake these inventions after the many failings of others, well knowing that, within ten miles of Dudley Castle, there be near 20,000 smiths of all sorts, and many iron-works at that time, within that circle, decayed for want of wood

(yet formerly a mighty woodland country). Secondly, the Lord Dudley's woods and works decayed, but pit-coal and ironstone, or mines, abounding upon his lands, but of little use. Thirdly, because most of the coal mines in these parts, as well as upon Lord Dudley's lands, are coals, ten, eleven, and twelve yards thick, the top or the uppermost coal, or vein, gotten upon the superficies of this globe or earth in open works. Fourthly, under this great thickness of coal are very many sorts of ironstone mines, in the earth, clay, or stone earth, like bats, in all four yards thick; also under these iron mines are several yards thick of coals, but of these in another place more convenient. Fifthly, knowing that, when the colliers are forced to sink pits for getting of ten yards thick or more, one third part of the coals that be gotten under the ground being small, are of little or of no use in that inland country, nor is it worth the drawing out of the pits, unless it might be made use of by making of iron therewith into cast works or bars. Sixthly, then, knowing that, if there could be any use made of the small coals that are of little use, then would they be drawn out of the pits, which coals produced oftentimes great prejudice unto the owners of the works and the work itself, and also unto the colliers, who, casting of the small coals together, which compelling necessity enforcing the colliers so to do, for two causes, one is to raise them to cut down the ten yards thickness of coals, drawing only the bigger sort of coal, not regarding the lesser or small coal, which will bring no money, saying—he that liveth longest let him fetch fire furthest. Next, these colliers must cast these coals and slack or dross out of their ways, which sulphurous small coal and crowded moist slack heat naturally, and kindle in the middle of these great heaps, often sets the coal works on fire, and flaming out of the pits, and continue burning, like Ætna, in Sicily, or Hecla, in the Indies.

"Yet, when these loose sulphurous composts of coal and slack being consumed in process of time, the fire decays; but, notwithstanding the fire hath continued in some pits many years, yet colliers have gotten coals again in those same pits, the fire not penetrating the solid and firmer wall of coals, be-

cause, *pabulum ignis est aer,* the air could not penetrate, but pass by it in the loose coal and slack, for coming into those pits afterwards, I have beheld the very blows of pikes or tools, that got the coal there formerly. Also from these sulphurous heaps, mixed with ironstone (for out of many of the same pits is gotten much ironstone or mine), the fires heating vast quantities of water, passing through these soughs or adits becometh as hot as the bath at Bath, and more healing and sovereign even for old ulcers and sores, because many of these baths proceed not only from common sulphur and vitriol of *Mars,* but also from *Solar* sulphur in this ironstone. I hope *filii artis* will excuse my digression from the making of iron with pit-coal, sea-coal, peat, or turf, and the melting of mines and metals, and refining of the same with the like fuel. The first patent being granted by King James, for thirty-one years, in the nineteenth year of his reign, upon just and true information, that the author had, the year before, made many tons of iron with pit-coal, at a furnace, or iron-work, in the chase at Pensnet, county of Worcester, besides cast-iron works of sundry sorts, with pit-coal; and also at two forges, or iron-mills, called Cradley Forges, fined the said iron into merchantable good bar-iron. But the year following the grant, or patent, for making of iron with pit-coal or sea-coal, there was so great a flood by rain — to this day called 'the great May-day flood' — that it not only ruinated the author's iron-works and inventions, but also many other men's iron-works; and at a market town, called *Sturbridge, in comitatu Wigorniæ,* although the author sent with speed to preserve the people from drowning, one resolute man was carried from the bridge there in the daytime; and the nether part of the town was so deep in water, that the people had much ado to preserve their lives in the uppermost rooms in their houses.

"My iron-works and inventions thus demolished, to the joy of many ironmasters, whose works escaped the flood, and who had often disparaged the author's inventions, because the author sold good iron cheaper than they could afford it, and which induced many of the ironmasters to complain unto King James, averring that the iron was not merchantable. As

soon as the author had repaired his works and inventions, to his no small charge, they so far prevailed with King James, that the author was commanded, with all speed possible, to send all sorts of bar iron up to the Tower of London, fit for making of muskets and carbines; and the iron being so tried by artists and smiths, that the ironmasters and ironmongers were all silenced, until the twenty-first of King James. At the then Parliament all monopolies were made null, and divers of the ironmasters endeavoured to bring the invention of making iron with pit-coal, &c., within the compass of a monopoly; but the Lord Dudley and the author did prevail, yet the patent was limited to continue but fourteen years.* After which Act, the author went on cheerfully, and made annually great store of iron, good and merchantable, and sold it unto divers men, yet living, at 12*l.* per ton. I also made all sorts of cast-iron wares, as brewing-cisterns, pots, mortars, and better and cheaper than any yet were made in these nations, with charcoal; some of which are extant, to be seen by any (at the author's house, in the city of Worcester) that desire to be satisfied of the truth in the said invention.

"Afterwards, the author was ousted of his works and inventions before-mentioned, by the ironmasters and others, wrongfully—over long to relate; yet, being unwilling his inventions (having undergone much charge and pains therein) should fall to the ground, and be buried in him, made him set forward his inventions again, at a furnace called Himley furnace, in the county of Stafford, where he made much iron with pit-coal; but, wanting a forge to make it into bars, was constrained, for want of stock, to sell the pig-iron unto the

* "Provided also, and be it declared and enacted, that this Act, or any declaracion, provision, penaltie, forfeiture, or other thing before mencioned, shall not extend to or be prejudiciall to a graunt or priviledge for or concerning the melting of iron ewer, and of making the same into cast-workes or barres, with seacoales or pitcoales, by his Majisties lettres patent, under the Great Seale of England, bearing date the twentith day of Februarie, in the nyneteenth yeare of his Majisties Raigne of England, made or graunted to Edward Lord Dudley, but that the same severall lettres patent and graunte shalle and remayne of the like force and effect, and as free from the declaracions, provisions, penalties, and forfeitures before mentioned, as if this Act had never byn had nor made, and not otherwise."—21 Jac. 1. c. 3. "*Statute of Monopolies.*"

charcoal ironmasters, who did him much prejudice, not only in detaining his stock, but also disparaging the iron—Himley furnace being rented out unto charcoal ironmasters.

"The author erected a new large furnace on purpose, twenty-seven feet square, all of stone, for his new invention, at a place called Hascobridge, in the parish of Sedgeley, and county of Stafford; the bellows of which furnace were larger than ordinary bellows are; in which work he made seven tons of iron per week, the greatest quantity of pit-coal iron that ever yet was made in Great Britain. Near which furnace the author discovered many new coal mines, ten yards thick, and iron mine under it, according to other coal works; which coal works being brought into perfection, the author was, by force, thrown out of them, and the bellows of his new furnace and invention, by riotous persons, cut in pieces, to his no small prejudice, and loss of his invention of making of iron with pit-coal, &c., so that being, with law-suits and riots, wearied and disabled to prosecute his art and invention at present, even until the first patent was extinct.

"Notwithstanding the author's sad sufferings—imprisoned wrongfully for several thousand pounds, in the Counter, in London, yet did obtain a new patent, dated May 2, *anno* 14, *Caroli Primi*, of ever blessed memory, not only for the making of iron into cast works and bars, but also for the melting, extracting, refining, &c., all mines, minerals, and metals, with pit-coal, sea-coal, &c., for the preservation of the wood and timber of this island; into which patent the author for the better support and management of his invention, so much opposed formerly at the Court, at the Parliament, and at the Law, took in David Ramsey, Esq., resident at the Court, Sir George Horsey, at the Parliament, Roger Foulke, Esq., a counsellor of the Temple, and an ingenious man, and also an ironmaster, my neighbour, and one who did well know my former sufferings, and what I had done in the invention of making of iron with pit-coal, &c. All which patentees articled the 11th June following the grant, not only to pay the author all the charges of passing the patent laid down by him, but also to lay in, for a common and joint-stock, each

man of the four, one hundred pounds, and so from time to time what more stock any three of the patentees should think fit to be laid in, for the making of iron into cast works and bars, and likewise for the melting, &c., with pit-coal, &c. (as above)—which articles are yet extant.

"Now, let me, without offence, insert the opposition we all had, by means of powerful ironmasters, with Sir Philibeard Vernat, a Dutchman, and Captain Whitmore, who pretended much unto his Majesty, but performed not their undertaking, which caused the author and his partners thus to petition:—

"'To the King's Most Excellent Majesty.

"'The humble petition of Sir George Horsey, Knt., David Ramsey, Roger Foulke, and Dud Dudley, Esquires, humbly showeth—That whereas your petitioners being called before the Right Honourable the Lord Keeper, by your Majesty's appointment, touching the making of iron with pit-coal, &c., for which they have your Majesty's patent; and seeing that Sir Philibeard Vernat, and Captain Whitmore, who are not inventors, have obtained a patent also for the same; yet, before the patent granted, Sir Philibeard was ordered at council board, according to his great undertaking, to perfect it, and his invention within two years; and there hath been near three years passed, and yet have made little or no iron; still he opposeth your petitioners, and doth neither benefit himself, but hinders your Majesty and the kingdom.'

"At the Court at Greenwich, May 20th, 1638, his Majesty is pleased to refer this petition to Master Attorney and Master Solicitor-General, to call the petitioners before them, and to compose the differences between them, if they can—or otherwise to certify his Majesty their opinions therein.

"Sir Sidney Montague was then Master of the Requests, but Sir Philibeard Vernat and Captain Whitmore never appeared any more for their invention.

"Not long after the wars came on, and caused my partners to desist, since which they are all dead but the author; and his estate (for his loyalty unto his late Sacred Majesty and

master), as by the additional Act of Parliament may appear, was totally sold. Yet, nevertheless, I still endeavoured not to bury my talents, took in two partners into my inventions —Walter Sevens, of Bristow, linendraper, and John Stone, of the same city, merchant. After the author had begun to erect a new work for the inventions aforesaid, near Bristow, *anno* 51, and there we three partners had in stock near 700*l.*; but they not only cunningly drew me into bond, entered upon my stock and work, unto this day detained it, but also did unjustly enter staple actions in Bristow, of great value against me, because I was of the King's party, unto the great prejudice of my inventions and proceedings, my patent being then almost extinct; for which, and my stock, am I forced to sue them in Chancery.

"In the interim of my proceedings, Cromwell and the then Parliament granted a patent and an Act of Parliament unto Captain Buck, of Hampton-road, for the making of iron with pit-coal and sea-coal. Cromwell, and many of his officers, were partners, as Major Wildman and others; many doctors of physic, and merchants, who set up divers and sundry works and furnaces, at a vast charge, in the Forest of Dean, and after they had spent much in their invention and experiments, which was done in spacious wind-furnaces, and also in pots of glass-house clay, and failing, afterwards got unto them an ingenious glass-master, Edward Dagney, an Italian, then living in Bristow, who, after he had made many pots for that purpose, I went with them into the Forest of Dean and built for the said Captain Buck and his partner a new furnace, and made therein sundry experiments and trials for the making of iron with pit-coal and sea-coal; but he failing, and his pots being all broken, he did return to Bristow frustrate of his expectation, but further promising to come again and make more experiments; at which time Master John Williams, Master Dagney's master of the glass-house, was then drawn in to be a partner for 300*l.* deposited, and most of it spent. The said Williams and Dagney hearing that the author had knowledge in the making of iron with pit-coal, sea-coal, &c., they, from Captain Buck, and the other partners, importuned

the author, who was at the time in great danger by the Parliament, being a colonel of the king's party, to go along with them into the Forest of Dean, which at that time durst not deny coming thither. I observed their manner at working, and found it impossible that the said Edward Dagney, by his inventions, should make any iron with pit-coal or sea-coal, in pots, to profit. I continued with them till all their pots and inventions failed. At every dinner and supper, Captain Buck, Captain Robins, Doctor Ivie, Doctor Fowler, and others, would ask the author why he was so confident that iron in quantity could not be made by their new inventions? I found it a difficult thing to dissuade the partners from their way, so confident were they to perform the making of iron with pit-coal or sea-coal to profit, that they desired me to come again a second time into the forest to see it effected; but at that time I saw their failings also, yet, nevertheless, Captain Buck and his partner erected nine works, at the city of Bristow, in which they did fail as much as in their former inventions.

"But Captain Wildman—more barbarous to me than a wild man — although a minister, bought the author's estate, near 200*l.* per annum, intending to compel from the author his inventions of making of iron with pit-coal; but afterwards passed my estate unto two barbarous brokers of London, that pulled down the author's two mansion houses, sold 500 timber trees off his land, and to this day are his houses unrepaired, *anno* 1655. Captain Buck and his partner, wearied of their invention, desisting *anno* 1656. Captain John Copley, from Cromwell, obtained another patent for the making of iron with pit-coal and sea-coal; he and his partner set up their works at the coal works near Bristow, and endeavoured by engineers' assistance to get his bellows to be blown at or near the pits of coal, with which engines the work could not be performed. But the author coming to see the said works, and after many discoveries with Captain Copley, his former acquaintance, told him plainly if his bellows could have been blown with those engines, yet I feared he could not make iron with pit-coal or sea-coal; he seemed disconcerted, whereupon, and

without these engines, I made his bellows to be blown forcibly, as by the note under his hand appears, as followeth:

"'1656, December 30.—Memorandum, the day and year above written: I, John Copley, of London, gent., do acknowledge that after the expense of divers hundred pounds to engineers, of the making of my bellows to blow, for the making of iron with pit-coal or sea-coal, near Bristow, and near the Forest of Kingswood, that Dud Dudley, Esq., did perform the blowing of the said bellows at the works or pits aforesaid, a very forcible and plausible way, that one man may blow them with pleasure the space of an hour or two; and this I do acknowledge to be performed with a very small charge, and without any money paid to him for the said invention. 'JOHN COPLEY.'

"Captain John Copley thus failing in his inventions, *anno* 1657, so he went into Ireland, and all men now desisting from the inventions of making iron with pit-coal and sea-coal, the author, *anno* 1660, being sixty-one years of age, and moved with pity, and seeing no man able to perform the mastery of making of iron with pit-coal or sea-coal, immediately upon his Sacred Majesty's happy restoration, the same day he landed, petitioned that he might be restored to his place, and his patent, obstructed, revived, for the making of iron with pit-coal, sea-coal, peat, and turf, into cast work and bars, and for the melting, extracting, refining, and reducing of all mines, metals, and minerals with pit-coal, sea-coal, peat, and turf—which said laudable inventions the author was, and is, unwilling should fall to the ground and die with him; neither is the mystery or mastery of the inventions effected and perfected by any man known unto the author as yet, either in England, Scotland, or Wales, all which three abound with pit-coal or sea-coal, and do over much furnish other kingdoms, many with pit-coal and sea-coal, when they might make better use of it themselves (especially Scotland and Wales) both for the making iron into cast works and bar, and also for the making of steel, and melting, extracting, and refining of lead, tin, and iron.

"The author petitioned his Sacred Majesty sitting at the

council board, for the renewing of his patent; the reference to that petition followeth: —

"The author during the Lords Commissioners' their time, could get no order upon his references, but his petition was left with the new Right Honourable the Lord Treasurer, to take or grant from their order therein, but the author hath gotten hitherto no order, therefore compelling necessity doth constrain (having prosecuted his petition hitherto) him to desist from his inventions, in which he hath taken more pains, care, and charge than any man to perfect his new inventions in these kingdoms. Although the author hath not as yet so fully perfected or raised his inventions to the quantity of charcoal iron furnaces, yet the author's quantity being but seven tons per week at the most, together with the quality of his iron made with pit-coal and sea-coal, hath the most eminent triplicity of iron of all that can be desired in any new invention: — 1. More sufficient; 2. More cheap; 3. More excellent — upon which triplicity the author might enlarge, but shall not be tedious, only give me leave to mention that there be three sorts of cast-iron. 1. The first sort is grey iron; 2. The second sort is called motley iron, of which one part of the sows or pigs is grey; the other part is white intermixed; 3. The third sort is called white iron; this is almost as white as bell metal, but in the furnace is least fined, and the most terrestrial.

"Of the three, the motley iron is somewhat more fined, but the grey iron is most fined in the furnace, and more malleable and tough than the other two sorts before mentioned, and of this sort is the iron made with pit-coal (sea-coal for the most part), and therefore more sufficiently to be preferred; 2. More cheap iron there cannot be made, for the author did sell pig or cast-iron made with pit-coal at 4*l.* per ton; many tons in the twentieth year of King James, with good profit. Also, the author did sell bar iron, good and merchantable, at 12*l.* per ton, and under; but bar-iron hath been sold for the most part ever since, at 15*l.*, 16*l.*, 17*l.*, and 18*l.* per ton, by charcoal ironmasters.

"3. More excellent for divers reasons, principally being

the means whereby the wood and timber of this island, almost exhausted, may be timely preserved yet, and vegetate and grow again into its former wonted cheapness, for the maintenance of navigation, which is the greatest strength of Great Britain, whose defence and offence for all the territories that belong unto it, next under God, and his vicegerent, our Sacred Majesty's cares consist most of shipping, men-of-war, experienced mariners, ordnance, ammunition, and stores; the ordnance made therewith will be more grey and tough, therefore more serviceable at sea and land, and the bar-iron will wall, rivet, and hold better than most commonly chargeable iron. But also in respect this my inventions will preserve many millions of tons of small coal in Great Britain, which will be lost in time to come, and as formerly they were; for within ten miles of Dudley Castle is annually consumed four or five thousand tons, at least, of small pit-coal, and have been so consumed time out of mind, underground, fit to have made pig-iron with, which coals are, and unless iron be made therewith, will be for ever totally and annually lost. If four or five thousand tons of coal be consumed within ten miles of compass, what coal is thus consumed in all England, Scotland, and Wales? which is no good husbandry for Great Britain. *Hinc illæ lacrymæ*, that our timber is exhausted. Must I still be opposed, and never ensured my invention, nor Great Britain the benefit? Must my patent be obstructed in peace, as it was extinct by the wars? And must not my patent be revived for the making of iron with pit-coal, sea-coal, peat, and turf, but find enemies still to oppose it? How many thousand tons of iron might have been made, but since my first invention it is saved one-eighth by my means with pit-coal, and sea-coal lost it, if I had not had enemies, and had not wood and timber been preserved. But most men will aver that it doth concern the author to demonstrate the great loss mentioned formerly of pit-coal annually; it is thus: — ' There is at least within ten miles of the Castle of Dudley twelve or fourteen coal works, some in Worcestershire, and some of them in Staffordshire, now in work; and twice as many in that circuit not in work; each of which works get

two thousand tons of coal yearly, some get three, four, or five thousand tons of coal yearly, and the uppermost or top measures of coals are ten, eleven, and twelve yards thick, the coals ascending (basseting was the colliers' term), it cropping up even unto the superficies of the earth, and there the colliers formerly got the coals; but where the coals are deep, and but little earth upon the measure of coals, there the colliers rid off the earth, and dig the coals under their feet; these works are called footrids, but of these works there are now but few. Some of these small coals in these open works the poor people did carry away, but paid nothing for them in former times, termed the braincarriages, but now the colliers working more in the deep of these works, they are constrained to sink pits, some of which pits are from eight unto twenty yards deep, and some are near twenty fathoms deep, which fathom contains two yards in these pits. After you have made or hit the uppermost measure of coals, and sunk or digged through them, the colliers getting the outermost parts of the coals first about two yards in height or more, and when they have wrought the cruts or stauls (as some colliers call them), as broad and as far in under the ground as they think fit, they throw the small coals, fit to make iron, out of their way on heaps, to raise them up so high to stand upon, that they may, with the working of their picks or maundrills over their heads, and at the one end of the coals, so far in as their tools will admit, and so high as their working cometh unto a parting in the measure of coals, the which coal, to the parting by his self-clogging and ponderous weight, often falls many tons of coals, many yards high, down at once; with which fall, and the colliers breaking of the said coal, many small coals do so abound of no use, and unfit for sale, that in getting of 20,000 tons of pit-coal, one-half is small coal not drawn out of the pits, but destroyed, left, and lost; which small coal, with the thrown moyest together heats the sooner, and by means of its sulphureous fire in the pits, to no small prejudice unto the owners of the works, and the workmen, besides Great Britain's loss, which coal might have made many thousand tons of iron,

and also have preserved this island's woods and timber.—I might here give you the names, and partly the nature of every measure parting of each coal lying one upon each other. The three uppermost measures are called the *white* measure, for *his* white arsenical, *satsuquorious,* and sulphureous substance, which is in that coal; the next measure is the *shoulder* coal, the *toe* coal, the *foot* coal, the *yard* coal, the *slipper* coal, the *sawyer* coal, and the *fristy* coal; these last three coals are the best for the making of iron, yet other coals may be made use of.

"I might give you other names of coals, but desire not prolixity, yet must I tell you of a supernumerary number of smiths within ten miles of these coal works, near twenty thousand. Yet God of his infinite goodness—if we will but take notice of his goodness unto this nation—hath made this country a very cranati, for the supplying these men with iron, coal, and lime, made with coal, which hath much supplied the men with corn also of late; and from these men a great part not only of this island, but also of his Majesty's other kingdoms and territories, with iron wares, have their supply; and wood in these parts almost exhausted, although it were of late a mighty woodland country. Now, if the coals and ironstone so abounding were made right use of, we need not want iron as we do, for very many measures of ironstone are placed together under the great ten yards thickness of coal, and upon another thickness of coal two yards thick, not yet mentioned, called the bottom coal or heathern coal, as if God had decreed the time when and how these smiths should be supplied, and this island also, with iron; and most especially that this coal and iron-stone should give the first and last occasion for the invention of making iron with pit-coal, no place being so fit for the invention to be perfected in as this country for the general good; whose lands did formerly abound in forests, chases, parks, and woods, but exhausted in these parts."

Now for the names of the iron-stone:—"The first measure is called the black-row-graines, lying in very hard and black earth; the second measure is the dun-row-graines, lying in

dun earth or clay; the third measure is called the white-row-graines, lying in very white earth or clay; under these three measures are sundry other measures, and are called—first, the rider-stone; secondly, the cloud-stone; thirdly, the bottom-stone; fourthly, the cannock or cannot-stone—which last may well be so called, although all the other measures be very good, yet this stone is so sulphureous and terrestrial, not fit to make iron, because the iron thereof made is very redshare—which is, that if a workman should draw or forge out a share-mould fit for a plough in that red heat it would crack, and not be fit for the use of the husbandman's plough or share.

"I may take occasion here to speak of the nature of coldshare-iron, which is so brittle if made of the grain ore, or ironstone, would be almost as brittle as some *regulus antimonii*, made with iron, for with one small blow over an anvil you may break the biggest bar that is, if it be perfect coldshare iron—nay, the ploughman often breaks his share-point off, if it be made of coldshare-iron; but perfect tough malleable iron will not break feasibly in hot heat or cold, as coldshare will, or red hot as sulphureous redshare-iron will, but yet tough enough when it is cold; all which aforesaid qualities of iron the author very well knoweth how to mend their natures, by fining or setting the finery less transhaw more burrow, which are terms of art, and by altering and pitching the works and plates, the fore-spirit plate, the tuiron bottom, back and breast or fore plate, by the altering of which much may be done, if the work be set transhaw and transiring from the blast; the iron is more coldshare, less fined, more to the master's profit, less profitable to him that makes it into manufactorage, and less profitable to him that useth it, but the iron made in a burrow work becometh more tough and serviceable, yet the nature of all ironstone is to be considered both in the furnace and in the finery; the sulphureous, arsenical, and veneriating qualities, which are oftentimes in ironstone, to be made to separate in both the works from the fixed and fixing bodies of iron, whose fiery quality is such that he will sooner self-calcine than separate from any sulphureous veneriated quality.

"No man, I hope, need to be offended at any terms of art; it hath been always lawful for authors of new arts and inventions, at their own pleasure, to give name to their new inventions and arts; every tradesman is allowed it in his mystery; but the author hath, as much as he could, avoided the terms of art that Simon Sturtevant and others have used, which are very many, only the author hath given you the common names and terms for the most part, which are so common among forgemen and founders, as is nothing more common, but keep secrets amongst them, and a mystery not yet known but unto very few owners of iron works; nay, I have not yet troubled your memory with any of the founders' terms, of but making his hearth—as the timpe-stones, the windwall-stone, the tuiron-stone, the bottom-stone, the back-stones, and the boshes, in the making and picking of which hearth is much of the mystery.

"I must confess there is given unto some philosophers and *filii artis* some few terms, how the sulphureous, arsenical, bituminous, antimonial, and other poisonous qualities, either in the pit-coal, sea-coal, or the iron-stone, may be in part at the furnace separated, and not permitted to be incorporated, yet by fining at the forge to pitch it out; also to melt, extract, refine, and reduce all mines, metals, and minerals, unto their species with pit-coal, sea-coal, peat, and turf, by ways not yet in use, which the author will make known hereafter, if God permit him health, time, and space, or leave his knowledge unto his brother, Aylmore Folliatt, Esq., his nephew, Parkhouse, Esq., and to his kinsman, Master Francis Dingby, to declare unto this latter age of the world in which God is pleased to manifest many of his secrets: *Qui vult secreta scire, secreta secrete sciat custodire.*

"Having suffered much ever since the year 1618 unto this present for the general good, as by the preceding discourse appears, for the making of iron with pit-coal, sea-coal, peat, and turf, for the preservation of wood and timber of Great Britain, which is much exhausted, for the future prevention of which is—1st, to permit the author to enjoy his patent, and fully to perfect his said intentions, obstructed in the reign both

of King James and in the reign of his sacred majesty King Charles the First, of ever-blessed memory, and lately since his most sacred majesty's happy restoration, who desires nothing but to be animated with the patent revived, according unto the statute of 21 Jacobi for inventions; 2d, to empower the author, or any other agents, to take care that no pit-coal or sea-coal be anyways wilfully destroyed underground; 3rd, to put all former good laws in execution, and to make others for the preservation of wood and timber of these nations, especially near navigable rivers or seas; 4th, seeing there goeth out of England, Scotland, and Wales, many thousand tons annually of pit-coal and sea-coal to furnish France, and also the smiths thereof, Spain, Portugal, and Flanders, and especially the smiths thereof, the Low Countries, and the smiths thereof—besides the Hollanders carry great quantities of our coals unto foreign parts, without which those countries cannot subsist. Now the author's design is, that where there is a conveniency of ironstone or ore, the coals may not be transported (paying his sacred Majesty's duty) until order from his Majesty, or his privy council; 5th, that no pit-coal be exported, seeing that wood fuel, and timber is decayed for building, and instead thereof brick-making (formerly spending wood, but now coals) is much in use. Also is glass now made with coals, but formerly there were many thousand loads of wood fuel spent in the making thereof, and the glass invention with pit-coal was first effected near the author's dwelling; 6th, making of malt brewings, making of copperas, alum, salt, casting of brass and copper, dyeings, and many other works, were not many years since done altogether with the fuel of wood and charcoal—instead whereof, pit-coal and sea-coal is now used as effectually and to a better use and purpose, besides the preservation of wood and timber; 7th, that which is somewhat nearer the mark and invention, the blacksmith forged all his iron with charcoal, and in some places where it is cheap they continue this course still, but small pit-coal and sea-coal, and also peat and turf, hath and doth serve the turn as well and sufficiently as charcoal; 8th, that which is nearest to, and my perfect in-

vention, and near the author's dwelling called Green's-lodge, there are four forges, namely, Green's forge, Swin forge, Heath forge, and Cradley forge, which four forges have barred all or most part of their iron with pit-coal, ever since the author's first invention in 1618, which hath preserved much wood in these four; besides many other forges do the like, yet the author hath had no benefit thereby to this present. Yet, by this barring of iron with pit-coal, 30,000 loads of wood and more have been preserved for the general good, which otherwise would have been consumed."

Simon Sturtevant, in his "Metallica," in the epistle to the reader, saith, that there was then, *anno* 12 Jacobi, in England, Scotland, Ireland, and Wales, 800 furnaces, forges, or iron mills, making iron with charcoal. Now we may suppose at least 300 to be furnaces, and each furnace making fifteen tons per week of pig or cast-iron, and work or blow but forty weeks per annum; but some furnaces make twenty tons of pig-iron per week, and two loads of charcoal or thereabouts go to the making of a ton of pig-iron, and two loads (or two cords) of wood at the least go to the making of a load of charcoal. Now what loads of wood or charcoal are spent in Great Britain and Ireland annually, but in one furnace, that makes fifteen tons per week of pig-iron for forty weeks, I shall give you the table, and leave you to judge of the rest of the furnaces:—

15 tons per week, spends of charcoal -	30 loads.	Wood -	60 loads.
Per annum, 40 weeks, spend charcoal -	1200 „	Wood -	2400 „

Also, for one forge that makes three tons of bar-iron weekly, for fifty weeks; but some forges make double my proportion, and spend to fine and bar out each ton, three loads of charcoal to each ton.

3 tons per week -	- Charcoal	-	9 loads.	Wood	- 18 loads.
per annum -	- Charcoal	-	450 „	Wood	- 900 „

It does not, however, appear that Dudley succeeded in his application, and the only further attempt which was made about this time is mentioned by Dr. Plot, in his "History of Staffordshire," he says—"The last effort that was made in

this country for making iron with pit-coal, was with raw coal, by a Mr. Blewstone, a German, who built his furnace at Wednesbury, so ingeniously contrived (that only the flame of the coal should come to the ore, with several other conveniences), that many were of opinion he would succeed in it. But experience, that great baffler of speculation, showed it could not be; the sulphureous vitriolic streams that issue from the pyrites, which frequently, if not always, accompanies pit-coal, ascending with the flame, and poisoning the ore, sufficiently to make it render much worse iron than that made with charcoal, though not, perhaps, so much worse, as the body of coal itself would possibly do."

This last experiment is expressly stated to have been made with "raw coal," but it does not appear that this arose from any want of knowledge of the method of coking the coal, as Dr. Plot further mentions: —

"They have a way of charring the coal, in all particulars the same as they do wood, whence the coal is freed from those noxious steams that would otherwise give the malt an ill odour. The coal thus prepared they call cokes, which conceives as strong a heat almost as charcoal itself, and is as fit for most other uses, *but for melting, fining, and refining of iron*, which it cannot be brought to do, though attempted by the most skilful and curious artists."

The various attempts to substitute pit-coal for charcoal having thus failed, no further experiments were made till the early part of the next century, when pit-coal was first used by Mr. Abraham Darby, in his furnace at Colebrook Dale, in 1713; and in the forty-fourth volume of the "Philosophical Transactions," published in the year 1747, it is stated, that "Mr. Ford, from iron ore and coal, both got in the same Dale (Colebrook), makes iron brittle or tough, as he pleases; there being cannon thus cast so soft, as to bear turning like wrought iron."

At this eventful era in the history of the manufacture of iron, when agriculture was progressively sweeping before it what remained of the once immense tracts of woodland, till then dedicated to the supply of the blast furnace, when the

increased application of machinery, and the introduction of the steam-engine, gave hope of new life and impulse to manufactures in general, the iron trade seemed dwindling into insignificance and contempt.

It was not until impelled by necessity that pit-coal again became an object of general consideration, nor until improvements in machinery had attained a great degree of certainty, and experience had taught the mechanic the manifest advantages of the steam-engine, that the adventurous manufacturer found that he possessed in the immense beds of coal an extent of means to which he had till then been a stranger. Small furnaces, supplied with air from leathern bellows, worked by oxen, horses, or human labour, were laid aside, and an increase of size took place, together with an increase of the column of blast necessary to produce combustion. But, notwithstanding the efforts that were then made, there was a gradual, but steady, diminution in the quantity of iron produced, although every year witnessed an increased demand for the article, particularly in its manufactured state.

Recourse was had to foreign markets for the necessary supply, and the immense annual importations from Russia and Sweden may date their origin from this period. The flourishing and extensive detail of Dudley no longer existed, and the 300 blast-furnaces, mentioned by him, were now diminished to fifty-nine, and their total annual produce to 17,350 tons, or not quite 300 tons from each furnace, which is further shown in the following table, distinguishing the number of furnaces, and the make in each county, in the year 1740:—

	No. of Furnaces.	Tons.		No. of Furnaces.	Tons.
Brecon -	2	600	Monmouthshire	2	900
Glamorganshire	2	400	Nottinghamshire	1	200
Carmarthenshire	1	100	Salop - -	6	2,100
Cheshire -	3	1,700	Staffordshire	2	1,000
Denbighshire	2	550	Worcestershire	2	700
Derbyshire -	4	800	Sussex -	10	1,400
Gloucestershire	6	2,850	Warwickshire	2	700
Herefordshire	3	1,350	Yorkshire -	6	1,400
Hampshire -	1	200			
Kent - -	4	400	Total -	59	17,350

Annual average for each furnace, 294 tons.

The following are the imports and exports of iron at this period:—

IMPORTS.

Years.	Average Tons.
1711 to 1718	15,642
1729 — 1735	25,501
1750 — 1755	34,072
1761 — 1776	48,980

EXPORTS.

1711 to 1718	4,365
1729 — 1735	5,334

Notes to Chap. II.

The first knives made in England were by one Thomas Mathews, of London, in the year 1563, when we imported the greatest part of our manufacture requisite from Flanders and other countries.—*Oddy's European Commerce.*

"June 20, 1662.—Drew up the agreement between the King (Charles the Second) and Sir John Winter, about the Forrest of Deane; and having done it, he came himself. I did not know him to be the Queen Dowager's Secretary before, but observed him to be a man of fine parts; and we read it, and both liked it well. That done, I turned to the Forrest of Deane, in Speede's mapps, and there he showed me how it lies; and the sea-bayly, with the great charge of carrying it to Lydny, and many other things worth my knowing; and I do perceive that I am very short in my business by not knowing many times the geographical part of my business."—*Pepys's Memoirs; Old Iron Furnaces in the Forest of Dean.*

"August 14, 1662.—Commissioner Pett and I being invited, went by Sir John Winter's coach, sent for us, to the Mitre, in Fanchurch Street, to a venison-pasty; where I found a very worthy man, and good discourse. Most of which was concerning the Forrest of Deane, and the timber there, and iron workes, with their great antiquity, and the vast heaps of cinders which they find, and are now of great value, being necessary for the making of iron at this day, and without which they cannot work: with the age of many trees there left at a great fall in Edward the Third's time, by the name of forbid-trees, which at this day are called vorbid trees."—*Ibid.*

Ship-building, and the founding of iron cannon, were the sole manufactures in which the English excelled in James the First's reign. They seem, indeed, to have possessed alone the secret of the latter, and great complaints were made every parliament against the exportation of English ordnance.—*Appendix to Hume's History of Great Britain.*

Charles the First, in 1637, by proclamation, ordered the pigs and bars of iron made in England to be marked by his surveyors of the iron works, to prevent the sale of bad iron, and that iron was not to be exported without the king's licence, under pain of forfeiture, &c. Those surveyors were also empowered to enter any woods that were felled, cut, or corded, to be converted

into coal for making of iron, whereby it might appear of what condition those woods were that should be employed that way, and that they be not cut down contrary to law.—*Macpherson's Annals of Commerce.*

1681.—Andrew Yarrington, in a work entitled "England's Improvement by Sea and Land," asserts that tin plates (iron plates tinned over) were now made in England through his means, he having learnt the art of making them in Bohemia. Little was at this time done in this manufacture; in the year 1720 it was one of the many projects set afloat, and, in 1740, it was brought to considerable perfection.

1685.—Manufacture of fine ironmongery in England improved by French refugees.

The ingenious William Chetwyord, of Rugely, Esq., at Madely furnace, cast iron rollers for gardens, hollow, like the mills for sugar canes, of 5, 6, 7, or 800 weight a-piece; the hollow whereof being filled with timber, and wedged up close, the other iron work of the roller is fastened to the wood in the same place as in other rollers, which are weightier and more substantial than any other rollers I have elsewhere seen. For such purposes as these, this serves well enough, but for others it will not, for it is so brittle, that, being heated, with one blow of a hammer it will break all to pieces.—*Plott's Nat. History of Staffordshire*, 1686.

In the early part of the eighteenth century, John Hanbury invented the method of rolling iron plates by means of cylinders, and introduced the art of turning into England.—*Coxe's Tour in Monmouthshire.*

CHAP. III.

IRELAND.

The history of the iron manufacture in England and Wales having been continued from its commencement to its state of prosperity, and subsequent decline, arising from the destruction of the forests, and, consequently, of the means of supplying the furnaces with the fuel, which at that time was indispensable, it will be desirable, before we enter on the account of more extensive operations, to give a short history of the manufacture in Ireland, and also in the British colonies of America.

To the English who settled in Ireland during and after the reign of Elizabeth, the Irish were indebted for the discovery of the iron mines of that country; the natives, constantly engaged either in quarrels amongst themselves, or with the old English as they were termed, that is, those who settled in Ireland from the time of the first conquest until the beginning of Queen Elizabeth's reign, had neither time nor inclination to attend to such inquiries; and the disorganised state of the country also operated on the settlers.

James the First came to the throne soon after the submission of O'Neil, in 1603, and immediately proceeded by a steady, regular, and well-concerted plan, to civilise the inhabitants, to reconcile them to laws and industry, and to render their subjection durable and useful to the crown of England, and, in the space of nine years, he made greater advances towards the reformation of that kingdom than had been made in the 440 years which had elapsed since the conquest was first attempted.

He abolished many Irish customs which supplied the place

of laws*, and which were calculated to keep that people for ever in a state of barbarism and disorder, and substituted English laws in their place; and having taken all the natives under his protection, and declared them free citizens, proceeded to govern them by a regular administration, military as well as civil, and no authority but that of the king and the law was permitted throughout the kingdom. During the peaceful interval which ensued, the English turned their attention to the mineral resources of the country, and, in a few years, discovered many iron mines in different parts of the kingdom, and, favoured by the extensive forests, carried on a considerable manufacture. Giraldus Cambrensis, who accompanied Henry the Second into Ireland on its first conquest, states that the country was then full of woods on every side, but the English, on gaining possession, cut them down, partly in order to deprive the banditti of their lurking places, and partly to gain the greater scope of profitable lands. Another cause operated, which operates in all countries—the desire to obtain wood for fuel. Forests, however, were still numerous in those parts, especially, over which the English had not acquired a perfect and tranquil power.

After the quelling of the great rebellion in Queen Elizabeth's time†, the forests were still more reduced in extent and number. The same motives which operated with the con-

* By the Brehon law or custom, every crime, however enormous, was punished, not with death, but by a fine or pecuniary mulct, which was levied upon the criminal. Murder itself, as among all the ancient barbarous nations, was atoned for in this manner; and each man, according to his rank, had a different rate or value affixed to him, which, if any one were willing to pay, he needed not fear assassinating his enemy. This rate was called his *eric*. When Sir William Fitzwilliams, being Lord Deputy, told Maguire that he was to send a sheriff into Fermannah, which a little before had been made a county, and subjected to the English law, "Your sheriff," said Maguire, "shall be welcome to me, but let me know, beforehand, his eric, or the price of his head, that if my people cut it off I may levy the money upon the county." As for oppression, extortion, and other trespasses, so little were they regarded, that no penalty was affixed to them, and no redress for such offences could ever be obtained.—*Hume.*

† O'Neil, Earl of Tyrone, deserted by his allies (the Spaniards) and troops, submitted almost at the very moment of the queen's death. Thus, Elizabeth lived just long enough to effect the subjugation of Ireland, a measure which had in vain been attempted by her predecessors.

querors on their first invasion operated afterwards. Besides, the prospect of gain by the sale of the timber was a further inducement, and immense quantities were shipped to foreign parts.

There were still, however, very extensive forests. In Leinster, the counties of Wicklow, and King and Queen's counties, were throughout full of woods, some many miles long and broad; also many parts of the counties of Wexford and Carlow. In Ulster, there were great forests in the county of Donegal, and in the north part of Tyrone, likewise in Fermanagh, along Lake Erne, in Antrim, and in the north part of Down; the greatest part of this latter county, however, as well as Armagh, Monaghan, and Cavan, were a good deal destroyed. In Munster, the counties of Kerry and Tipperary possessed sundry great forests.

The iron mines are divided by Gerard Boate, in his "Natural History of Ireland," into three descriptions:—1st, what he styles the bog mine, or, what is now termed, lowland ore, found in moors and bogs; the ore resembling a yellow clay, but, after long exposure to the air, mouldering into a blackish sand. 2d. The rock mine; a bad sort, the ore intimately combined with stone. "This mine or ore is not altogether so rich as the bog mine, and yieldeth very brittle iron, hardly fit for anything else but to make plough-shares (from whence the name of 'colt-share' iron is given unto it), and therefore it is seldom melted alone, but mixed with a portion of the bog ore." Of this ironstone only two mines were discovered, the one in Munster, near the town of Tallow, where the Earl of Cork established his iron works; and the other in Leinster, in King's county, in a place called Desart, land belonging to Sergeant-Major Piggot—this iron mine was very extensive, and supplied many iron works which were established in its immediate neighbourhood. The third sort he calls by different names—the fire mine, white mine, and shell mine. "The iron made from this ore is not brittle, as that of the rock mine, but tough, and, in many places, as good as any Spanish iron."

This mine was found in several parts of the kingdom—in

Ulster, in the county of Fermanagh, upon Lough Erne; in the county of Cavan, in a place called Doubally; and in the county of Nether-Tyrone, by the side of the rivulet Lithaw, not far from Lough Neagh, at the foot of the mountains Sluvgalen; in Leinster, in King's county, near Mountmellick; and in Queen's county, two miles from Limerick; in the county of Roscommon, by the side of Lough Allen; and in the county of Leitrim, on the east side of the same lake, where the mountains are so full of this metal that the Irish have given them the name of "Slew-Neren"—mountains of iron; in the province of Munster also these mines were found in various places. These mines having been discovered, the English commenced opening them, and erecting iron works in many parts of the country. The most extensive works were those of the Earl of Cork, in Munster; of Sir Charles Coote, in the counties of Roscommon and Leitrim, in Connaught; and in Leinster, by Montrath, in Queen's county; of the Earl of Londonderry, at Ballonakill, in the same county; the Lord Chancellor (Sir Adam Loftus*), and Viscount Ely, at Mountmellick, in King's county; Sir John Dunbar, in Fermanagh, in Ulster; and another in the same county, by the side of Lough Erne, by Sir Leonard Blenerhasset; in the county of Thomond, by some London merchants; besides some other works in other places, whose first erectors we have not been able to ascertain.

In imitation of these there were also many iron works erected in different parts of the sea-coast of Ulster and Munster, by persons who, having no mines in or near their own lands, purchased the ore in England†, which they found

* One of the charges brought against the Earl of Strafford on his trial was his extraordinary proceeding against the Lord Chancellor Loftus:—"The endeavour was, to compel the Lord Chancellor to settle more of his land, and in another manner, upon his oldest son, than he had a mind to, and than he could legally be compelled to; this the Earl (Strafford) upon a paper petition preferred to him by the wife of that son (a lady for whom the Earl had so great a value and esteem that it made his justice the more suspected), pressed, and, in the end, ordered him to do. The Chancellor refused, was committed to prison, and, shortly after, the Great Seal taken from him, which he had kept with great reputation of ability for the space of above twenty years."—*Clarendon's History of the Rebellion.*

† Three miles to the west of Ulverston, is Whitrich (the Peru of Furness),

cheaper than if they had caused the mine to be brought over land from mines in the interior.

The works we have here noticed were all of them bar-iron works, but there were some foundries where they cast ordnance, pots, small round furnaces, and other cast iron wares; the only work which is expressly mentioned is that of Christopher Windesford, Esq., Master of the Rolls in Ireland. Upon the Earl of Strafford quitting that kingdom, he was appointed Lord Deputy*—he had an extensive iron foundry on his lands by Idough, in the county of Carlow.

The materials which we possess to found a history of the extent of the manufacture at this period are extremely meagre; but that it must have been very considerable we ascertain from Boate, who observes—

"The Earl of Cork, whose iron mines being seated in Munster, afforded unto him very good opportunity of sending his iron out of the land by shipping, did in this particular surpass all others, so as he hath gained great treasures thereby; and knowing persons who have had a particular insight into his affairs, do assure me that he hath profited above one hundred thousand pounds clear gain by his said iron works."

He then enters into a more particular description of the works of Sir Charles Coote †, which appear, from the following account, to have been very extensive:—

"Nevertheless, few of them gained more or as much as Sir Charles Coote, because they had not the same conve-

iron ore is found there at the depth of from twenty to thirty yards; it is raised at 3*s*. 6*d*. and 4*s*. per ton, and pays 1*s*. 6*d*. per ton to the lord of the soil. It is carted and put on board vessels for exportation at 3*s*., and sells from 11*s*. to 12*s*. per ton.—*West's Antiquities of Furness.*

* 3rd of April, 1630.

† On the breaking out of the rebellion, in 1641, Sir Charles Coote was appointed Governor of the city of Dublin. "Pursuing the rebels at Trim (1642), he was unfortunately shot in the body, as it was thought, by one of his own troopers, whether by design or accident was never known; it being, for many months after his death, generally reported, and as generally believed, that he was accidentally slain by one of the flying rebels, who, in despair, turned about and discharged his musket at him. And this end had this gallant gentleman, who began to be so terrible to the enemy as his very name was formidable to them. His body was brought to Dublin, and there interred with great solemnity—floods of English tears accompanying him to the grave."—*History of the Irish Rebellion.*

niency of transportation; and he himself did not gain so much by his iron works in Connaught as by that at Mountrath, although the mines there afforded a richer ore, and that the ton thereof did cost him but three shillings at the furnace, because that Lough Allen, whereunto the same mines and works are contiguous, gave him the opportunity of carrying the ore by water from the mine unto the works, and that in boats of forty tons. At that work (Mountrath, in Queen's county) the ton of rock mine at the furnace head came in all to stand in five shillings and sixpence sterling, and the ton of white mine, which he had brought from a place two miles further off, in seven shillings; these two were mixed in that proportion, that to one part of rock mine were taken two parts of white mine, for if more of the rock mine had been taken, the iron would not have been so good, and too brittle; and being thus mixed, they yielded one-third part of iron — that is to say, of two tons of white mine, and one of rock mine, being mingled and melted together, they had one ton of good iron*, such as is called merchant iron, being not of the first, but second melting, and hammered out into bars, and, consequently, fit for all kinds of use.

"This iron he sent down the river Nore, to Ross and Waterford, in that kind of Irish boats which are called cots in that country, being made of one piece of timber; which kind of ill-favoured boats are very common throughout all Ireland, both for to pass rivers in, and to carry goods from one place to another, and not only upon shallow waters, such as the aforenamed river is, in the greatest part of its course, but even upon the great rivers and loughs.

"At Waterford the iron was put on board ships going to London, where it was sold for sixteen, otherwise for seventeen pounds, sterling, and sometimes for seventeen and a

* In most of the other places did a ton of the iron mine or ore come to stand in 5*s.*, 5*s.* 6*d.*, and 6*s.* sterling at the furnace head; and it was an ordinary thing, as well where they used white mine as where they mixed rock mine with it, to have a ton of good iron out of three tons of ore; in some places where the ore was richer they could have a ton of iron out of only two tons and a half of ore.—*G. Boate's Nat. Hist. of Ireland.*

half; whereas, it did not stand Sir Charles Coote in more than betwixt ten and eleven pounds sterling, all charges reckoned, as well of digging, melting, fining, as of carrying, boat hire, and freight, even the custom also comprehended in it.

"It is to be observed, that although there be wood enough upon one's land, and that not very far from the mine, together with the conveniences of water-courses, so as the water needeth not to be brought from very far off, nevertheless the charge is very great, both of erecting and stocking one of the iron-works, and of maintaining it and keeping it a-foot, and that by reason of the great number of workmen and labourers of several sorts which thereunto is requisite.

"Of all which sorts of men, Sir Charles Coote, the elder, that zealous and famous warrior in this present war against the Irish rebels (wherein having done many memorable exploits, he lost his life in the first year thereof), did continually keep at work some five-and-twenty, or six-and-twenty hundred, at his iron works, being three in number, whereby may easily be gathered the greatness of the expenses in the erecting and maintaining of iron-works; and for all this the owners thereof did greatly gain thereby, ordinarily no less than forty in the hundred per annum."

In the general destruction of property belonging to the English, almost the whole of the iron-works were destroyed by the rebels; in the neighbourhood of Lough Conn, in the county of Mayo, there were some valuable iron-works remaining, and these were continued as long as they could obtain a supply of fuel.

At a later period, about 1660, Sir William Petty* erected extensive iron-works, near the village of Blackstones, in the county of Kerry; these works were carried on till towards the middle of the last century, when, having exhausted all the timber in the neighbourhood, they were obliged to stop

* At the Restoration, Mr. Petty was treated with great attention by the King, and knighted, and created Surveyor-General of Ireland. His son was created Lord Shelburne by King William.—*Lemp. Biog. Dict.*

the works. It seems a little surprising that Sir William Petty should not have taken more care to preserve his woods, by copsing them up as they were cut down, as the practice is in Sweden, and other countries where there are iron-works, by which means a continual succession of underwood is obtained, but as these woods grow upon the best and driest soils, the persons who first cut them down, found the ground, thus cleared of trees, to be the most suitable places for pasture, and therefore neglected to keep them up.

Sir William Petty, in his political anatomy of Ireland, remarks that in 1672 there were 1000 tons of iron made in Ireland, which gave employment to 2000 men and women; and that there were 6600 smiths' forges, or rather, as he thinks, one-fifth more, and that the men and women employed therein amounted to 22,500.

By an Act passed in England, in the eighth year of William the Third, the duties on bar-iron, and iron slit and hammered into rods, imported from Ireland, were taken off, in consequence of the then depressed condition of manufacturing industry in Ireland. This removal of duty naturally occasioned a great demand for Irish timber, which, moreover, was constantly imported into England at the value, as stated in the Book of Rates, of 13*s.* 4*d.* the ton, and, consequently, liable to scarcely any duty. The unsettled state, besides, in which Ireland had long been, and the refuge which its forests afforded to criminals, outlaws, and those who were hostile to the existing government, rendered the landlords careless with regard to the preservation of their woods, or rather, it should seem, averse to their existence; for in many old leases, clauses are to be found requiring the tenants to use no other article for fuel but timber.

From these causes, a scarcity was soon experienced, to such a degree as to lead the parliament of Ireland, in order to put a stop to this improvident waste, to pass an Act * for planting and preserving timber trees and woods, of which the preamble runs thus:—"Forasmuch as by the late rebellion

* 10th William III. c. 12.

in this kingdom, and the several iron-works formerly here, the timber was utterly destroyed," &c.

This Act required that 260,600 trees should be planted in Ireland, proportionably in the several counties, and laid heavy penalties on such persons as neglected to comply with the requisition. It also required proprietors and tenants to plant a certain number annually, and the persons, or societies, who had iron-works, to plant 500 in each year, during the continuance of their works. But the number of trees was inconsiderable, and no effect of an extensive and permanent nature appears to have been produced. The Act too was defective, inasmuch as it did not provide against the waste of such few woods as still remained.

Besides, the consumption of home-made iron and Irish timber was left unchecked by the importation of foreign iron and timber, as heavy duties on these continued until 1703, when they were reduced to 5*s.* custom and 5*s.* excise per ton on iron, 6*d.* custom and 6*d.* excise per 1000 staves, 1*d.* per 1000 on hoops and laths, and 1*d.* per barrel on bark. The same Act, 2nd Anne, c. 2, laid a duty of 2*l.* 10*s.* on every ton of timber and plank, 5*s.* on every 1000 hoops or laths, and 3*l.* on every 1000 staves exported from Ireland, except to England—an exception which was calculated to render the Act in a great degree nugatory. Moreover, by the 4th Anne, c. 9, the penalties incurred by non-compliance with the requisitions in the 10th William III. c. 12, were remitted to such as had not paid them, and further time was given to avoid them—in other words, the latter statute was virtually repealed. It was finally so by the 8th George I. c. 8, which acknowledged that the Act in question had proved ineffectual.

The manufacture of iron was thus lost to Ireland, and, with a single exception, no attempt has been made to revive it. A furnace was erected about fifty or sixty years since by a family of the name of O'Reilly, and was worked by them, and also since, on two or three occasions. An English company, called the Arigna Company, took this property, and added a new furnace.

CHAP. IV.

BRITISH COLONIES IN AMERICA.

It was in the year 1516 that the British first took a share in American trade. Sir Walter Raleigh's discovery of Virginia, in 1584, and his attempts to colonise the English failed; but in the reign of James the First better regulations were made, and colonisation was successful for a time: in succeeding reigns it arrived at importance. We soon perceive the gradual increase of British dominion, and the colonies rising into consequence, and, by victory over the French, increasing, until the unhappy war with the mother country, which ended in the union of the States, and their establishment in independence.

Iron was first made in America in the province of Virginia, about the year 1715, and the example was quickly followed by the provinces of Maryland and Pennsylvania. This opening of a new source of wealth was a subject of great satisfaction and importance to those who were interested in the prosperity of the colonies, presenting to their view, at no distant date, a prospect of independence of foreign countries for the supplies of those most essential articles, iron and timber. That it was considered in this light is shown by a writer of that day, who observes —

"That the waste and destruction of the woods in the counties of Warwick, Stafford, Worcester, Hereford, Monmouth, Gloucester, and Salop, by their iron-works, is not to be imagined, and that if some care be not taken to preserve our timber from these consuming furnaces, there will not be oak enough left to supply the royal navy and our mercantile shipping. That, within these sixty years, Ireland was better

stocked with oak timber than we now are; but the iron-works since set up there have, in a few years, swept away the wood to that degree, that they have not small stuff enough to produce bark for their tanning, nor timber for common uses, insomuch that at present they are forced to have bark from England, and building timber from Norway, and to suffer their large hides to be exported untanned to Holland, Germany, and other countries. That about 20,000 tons of iron are annually imported into England from foreign parts, over and above what is made at home, for which we pay ready money, which at 12*l.* per ton, comes to 240,000*l.*, paid annually to foreigners; and the boards and other timber which we take of them come to 200,000*l.* more; whereas, our own plantations would be paid for their iron and timber in our own manufactures, thereby evidently bringing a double benefit to the nation. That they have ironstone all along the continent, from the southernmost part of Carolina to the northernmost part of New England, in great plenty, and no part of the world abounds more with prodigious quantities of wood, nor with more rivers and streams. That the Swedes have laid near 25 per cent. additional duty on their iron, and that the interruptions of our trade in the Baltic had greatly distressed our iron manufactures for want of iron. That, by the naval store laws now in force, which comprehend only pitch, tar, and turpentine, such great quantities thereof are produced and imported from our plantations as enable us to export great quantities thereof to the Straits, Spain, Portugal, Holland, Bremen, and Hamburgh. That, taking timber and iron, as well as flax and hemp, from our plantations, would employ a vast many ships and people. That iron, in particular, is a commodity of universal use, and certain in all parts of the world, and therefore as much to be valued as gold or silver. That the Dutch supply Portugal, the Straits, and Turkey, with great quantities of iron, and had we a full supply of it from our plantations, we might not only ballast our ships with it, but export great quantities to those countries, and even to Africa and India." But the proprietors of our own works took a very different view of the matter, to

them it was a cause of great jealousy and uneasiness, and they used every exertion to render inoperative the legislative enactments which were intended for the encouragement of the manufacture.

In 1719 a bill was brought into Parliament with the object of rendering the laws concerning the importation of naval stores from the British American plantations more comprehensive, by admitting from them all sorts of timber: —

"For whereas in our trade thither, it sometimes happens that the crops of tobacco, sugar, &c., fall short, many ships in that case are obliged to come home to Great Britain bad freighted, and some remain there a whole season, waiting for the next crop."

It was therefore imagined by the House of Commons, that if encouragement were given for bringing timber from our plantations, full freight would be secured for our ships, and the demand from our northern colonies, for British manufactures of all kinds, would be greatly increased, and their people diverted from further attempts to become themselves the manufacturers of such productions as could be much more advantageously furnished to them by Great Britain and Ireland. But the colonies were so surprised and disappointed by some clauses in the bill, that rather than submit to them they preferred to forego entirely the benefits it would have conferred upon them, and they were very glad to have it dropped altogether. Such for instance, "that none of the plantations should manufacture iron wares of any kinds, out of any sows, pigs, or bars, whatsoever, under certain penalties." By which clause no smith in the plantations might make as much as a bolt, spike, or nail, whereby the colonies must have been brought into a miserable condition, the smith being, above all other trades, absolutely necessary in all employments there; amongst the rest, that of shipbuilding would have been utterly destroyed, although thereby they made a great part of their returns for the British manufactures. The House of Peers added another clause — "That no forge going by water, or other work whatsoever, should be erected in any of the plantations, for

making sows, pigs, or cast iron, into bar or rod iron." This second clause must have ruined all the iron-works in the colonies to the great loss of their proprietors, and have given the French a fair handle to tempt them into their settlements.

Much was said in pamphlets and newspapers in the year 1737, in favour of the importation of iron and hemp from the British American Colonies, as being two articles of the first importance for our navy and mercantile shipping, as well as for numberless other services, and petitions were presented to Parliament for this end by the merchants.

1st. It was computed that England imported annually about 20,000 tons of foreign iron, whereof 15,000 tons were from Sweden, which cost about 150,000*l.*, and was mostly paid for by us in money, as was most of the other 5000 tons brought from Russia, and that our exports of wrought-iron were from 3000 to 3500 tons per annum.

2nd. That the iron of the British colonies is as good as any foreign iron whatever, and, with proper encouragement, might be imported in quantities sufficient to supply all the iron we get from the two nations on whom we are at present dependent for that commodity, without their taking sufficient of our product and manufactures in return; whereas, our own colonies would be entirely paid by our manufactures, the demand for which would thereby be much increased, and 180,000*l.* per annum would be clearly saved to the nation in the balance of our trade. It was, moreover, computed that England makes annually about 18,000 tons of bar iron; the quantity of which, it was said, we could not increase, by reason of our woods being so far exhausted as to have greatly enhanced the price of cord wood used in the refining of iron-stone; and were we to import more pig-iron from America, and make less of it at home, we should be able, with the same quantity of wood we now consume, to make much more bar-iron at home.

3rd. That nothing is more likely to prevent our American colonies from falling into such manufactures, as must intercere with our own, than giving them encouragement to pro-

duce such rough materials as pig, sow, and bar iron, hemp, &c., as it is well known of what great advantage to this kingdom the bounties on the importation of pitch and tar from thence have been since the year 1703.

4th. That for this end a duty should be laid in our colonies on all iron imported there from Europe.

On the other hand, the great and natural opposers of the merchants' petitions were the proprietors of the English iron-works and of the woodlands of England. The promoters of this scheme, for encouraging the importation of iron from our American colonies, proposed that an additional duty should be laid on all foreign bar-iron imported, excepting only such as shall be imported from our American colonies, and to repeal the present foreign duty on all bar-iron which may be hereafter imported from our plantations; but so many jarring interests prevented the legislature at that time from passing any new law on the subject.

In the year 1750, an Act, 23rd Geo. II., was passed, for encouraging the importation of pig-iron from the British colonies in America. Every well-wisher to his country reflected with concern on the nature of the British trade with Sweden, from which kingdom we imported more iron and steel than all the other countries in Europe. For this article a great balance was paid in ready money, which the Swedes again expended in purchasing from the French and other mercantile states those necessaries and superfluities with which they might have been as cheaply furnished by Great Britain. In the meantime, our colonies were restricted by severe duties from taking advantage of their own produce, in exchanging their iron for such commodities as they were under the necessity of procuring from the mother country. This restriction was not only a grievance upon our own settlements, but also attended with manifest prejudice to the interest of Great Britain, annually drained of great sums, in favour of a nation from whom we derived no advantage in return. Whereas, the iron imported from America must of necessity come in exchange for our own manufactures. The Commons having appointed a day for taking this affair into

consideration, carefully examined into the state of the British commerce carried on with Sweden, as well as into the accounts of iron imported from the plantations of America; and a committee of the whole House having resolved, that the duties on American pig and bar-iron should be repealed, a bill was brought in for that purpose. "That pig-iron, made in the British colonies in America, may be imported duty free, and bar-iron into the port of London; no bar-iron so imported to be carried coastwise, or to be landed at any other port, except for the use of his Majesty's dockyards; and not to be carried beyond ten miles from London."

The Act, however, contained the following clause:—"That from and after the 24th day of June, 1750, no mill or other engine for slitting or rolling of iron, or any plating forge, to work with a tilt hammer, or any furnace for making steel shall be erected, or, after such erection, continued in any of his Majesty's colonies of America."

And the governors of the colonies were ordered to transmit, for the information of government, an account of all slitting mills, plating forges, and furnaces for making steel; and this return was accordingly made in the ensuing year.* This precaution being taken, that the colonies might not interfere with the manufactures of their mother country. During the progress of this bill, which made its way through both Houses, and obtained the Royal assent, the tanners in and about the town of Sheffield, in Yorkshire, represented, that if the bill should pass, the English iron would be undersold, consequently, a great number of furnaces and forges would be discontinued; in that case, the woods used for fuel would stand uncut, and the tanners be deprived of oak bark sufficient for the continuance and support of their occupation. They, nevertheless, owned, that should the duty be removed from pig-iron only, no such consequence could be apprehended, because, should the number of furnaces be lessened, that of forges would be increased. This was likewise the plea

* Four mills or engines for slitting or rolling iron, one not in use.
Eleven plating forges to work with a tilt hammer, two not in use.
Five furnaces for making steel, one not in use.

urged in divers remonstrances by masters of iron-works, gentlemen, and freeholders, who had tracts of woodland in their possession. The owners, proprietors, and farmers of furnaces and iron forges, belonging to Sheffield and its neighbourhood, enlarged upon the great expense they had incurred in erecting and supporting iron-works, by means of which great numbers of his Majesty's subjects were comfortably supported. They expressed their apprehension that, should the bill pass into a law, it could not in any degree lessen the consumption of Swedish iron, which was used for purposes to which neither the American nor British iron would be suitable; but that the proposed encouragement of the manufacture of iron in America, considering the plenty and cheapness of wood, would enable the colonies to undersell the British iron—a branch of traffic which would be totally destroyed—to the ruin of many thousand labourers, who would be compelled to seek their livelihood in foreign countries. They likewise suggested, that if all the iron manufacturers of Great Britain were to depend upon a supply of iron from the plantations, which must ever be rendered precarious by the hazard of the seas and the enemy, the manufactures would probably decay for want of materials, and many thousand families be reduced to want and misery.

On the other hand, the ironmongers and smiths belonging to the flourishing town of Birmingham, in Warwickshire, presented a petition, declaring that the bill would be of great benefit to trade, as it would enable the colonists to make larger returns of their own produce, and encourage them to take a greater quantity of the British manufactures. They affirmed, that all the iron-works in Great Britain did not make half the quantity of the metal sufficient to carry on the manufacture; that, if this deficiency could be supplied from the colonies in America, the importation from Sweden would cease, and considerable sums of money be saved to the nation. They observed, that the importation of iron from America could no more affect the iron-works and freeholders of the kingdom than the like quantity imported from any other country; but they prayed that the people of

America might be restrained from erecting slitting, or rolling mills, or forges for plating iron, as they would interfere with the manufactures of Great Britain.

Many remonstrances to the same effect were presented from different parts of the kingdom; and it appeared, upon the most exact inquiry, that the encouragement of American iron would prove extremely beneficial to the kingdom, as it had been found upon trial applicable to all the uses of Swedish iron, and as good in every respect as the produce of that country.

Such are the connexions, dependencies, and relations subsisting between the mechanical arts, agriculture, and manufactures of Great Britain, that it requires study, deliberation, and inquiry in the legislature to discern and distinguish the whole scope and consequences of many projects offered for the benefit of the commonwealth. The society of merchant adventurers in the city of Bristol alleged, in a petition to the House of Commons, in the year 1756, that great quantities of bar-iron were imported into Great Britain, from Sweden, Russia, and other parts, chiefly purchased with ready money, some of which iron was exported again to Africa and other places, and the rest wrought up by the manufacturers. They affirmed that bar-iron, imported from North America, would answer the same purposes, and the importation of it tend not only to the great advantage of the kingdom, by increasing its shipping and navigation, but also to the benefit of the British colonies. That, by an Act passed in the 23rd year of his present Majesty's reign, the importation of bar-iron from America into the port of London, duty free, was permitted. But to carry coastwise, or further by land than ten miles, had been prohibited, so that several very considerable manufacturing towns were deprived of the use of American iron, and the outports prevented from employing it in their export commerce. They requested, therefore, that bar-iron might be imported from North America into Great Britain, duty free, by all his Majesty's subjects. This request being supported by many other petitions from different parts of the kingdom, other classes of men, who thought that their several interests

would be affected by such a measure, took the alarm, and, in divers counter-petitions, specified many ill consequences which they alleged would arise from its being passed into a law. Pamphlets were published on both sides of the question, and violent disputes arose on this subject, which was justly deemed a matter of national importance.

The opposers of the bill observed, that large quantities of iron were yearly produced at home, and employed multitudes of poor people, there being no less than 109 forges in England and Wales, besides those erected in Scotland; the whole producing 18,000 tons of iron. That as the mines in Great Britain are inexhaustible, the produce would of late years have been considerably increased, had not the people been kept under continual apprehension of seeing American iron admitted duty free—a supposition which had prevented the traders from extending their works, and discouraged many from engaging in this branch of traffic. They alleged that the iron-works already carried on in England occasioned a consumption of 198,000 cords of wood, produced in coppices that grow upon barren lands, which could not otherwise be turned to any good account. That, as the coppices afforded shade, and preserved a moisture in the ground, the pasture was more valuable with the wood than it would be if the coppices were grubbed up; consequently, all the estates where these now grow would sink in their yearly value. That these coppices, now cultivated and preserved for the use of the iron-works, are likewise absolutely necessary for the manufacture of leather, as they furnish bark for the tanners; and that, according to the management of these coppices, they produced a great number of timber trees, necessary for the purposes of building. They asserted, that neither the American iron, nor any that had yet been found in Great Britain was so proper for being converted into steel as that which comes from Sweden, particularly that sort called ore-ground; but as there are mines in the northern part of Britain, nearly in the same latitude with those of Sweden, furnished with sufficient quantities of wood, and rivers for mills and engines, it was hardly to be doubted that people would find metal of the

same quality, and in a few years, be able to supersede the necessity of importing iron either from Sweden or Russia. They inferred that American iron could never interfere with that which Great Britain imported from Sweden, because it was not fit for edged tools, anchors, chain plates, and other articles required in ship building; nor diminish the importance of Russian iron, which was not only stronger than the American and British, but also could be afforded cheaper than that brought from our own plantations, even though the duty on this last should be repealed. The importation of American iron, therefore, duty free, could interfere with no other sort but that produced in Britain, with which, by means of this advantage, it would clash so much as to put a stop in a short time to all the iron-works now carried on in the kingdom, and reduce to beggary a great number of families whom they now support.

To these objections the favourers of the bill replied, that when a manufacture is much more valuable than the raw materials, and these cannot be produced at home in sufficient quantities, and at such a price as is consistent with the preservation of the manufacture, it is the duty of the legislature to admit a free importation of these materials, even from foreign countries, although it should put an end to the production of that material in this island. That, as the neighbours of Great Britain are now more attentive than ever to their commercial interests, and are endeavouring to manufacture their rough materials at home, this nation must take every method for lowering the price of materials, otherwise, in a few years, it will lose the manufacture, and instead of supplying other countries, be furnished by them with all the fine toys and utensils made of steel and iron. That, being in danger of losing not only the manufacture, but the produce of iron, unless it can be procured at a cheaper rate than that at which it is sold at present, the only ways of averting this evil are, by diminishing the duty payable upon the importation of foreign iron, or by rendering it necessary for the masters of the iron mines in Great Britain to sell their produce cheaper than it has been for some years afforded. That

the most effectual method for this purpose is to raise up a rival, by permitting a free importation of all sorts of iron from the American plantations. That American iron can never be sold so cheap as that of Britain, for in the colonies labour of all kinds is much dearer than in England; if a man employ his own slaves, he must reckon in his charge a great deal more than the common interest of their purchase-money, because when one of them dies, or escapes from his master, he loses both interest and principal. That the common interest of money in the plantations is considerably higher than in England, consequently, no man in that country will employ his money in the branch of trade by which he cannot gain considerably more per cent. than is expected in Great Britain, where the interest is low and the profit moderate—a circumstance which will always give a great advantage to the British miner, who likewise enjoys an exemption from freight and insurance, which press heavily on the American adventurer, especially in time of war. With respect to the apprehension of the leather tanners, they observed that, as the coppices generally grow on barren lands, not fit for tillage, and improved the pasturage, no proprietor would be at the expense of grubbing up the wood to spoil the pasture, as he could make no other use of the land on which it was produced. The wood must be always worth something, especially in counties where there is not plenty of coal, and the timber trees would produce considerable advantage; therefore, if there were not one iron mine in Great Britain, no coppice would be grubbed up, unless it grew on a rich soil, which would produce corn instead of cordwood, consequently the tanners have nothing to fear, especially as planting hath become a prevailing taste among the landholders of this island.

The committee appointed to prepare the bill, seriously weighed and canvassed these arguments, examined disputed facts, and inspected papers and accounts relating to the produce, importation, and manufacture of iron. At length Mr. John Pitt reported to the House their opinion, implying that the liberty granted by an Act passed in the 23rd year of his Majesty's reign, of importing bar-iron from the British colo-

nies in America into the port of London, should be extended to all the other ports of Great Britain, and that so much of that Act as related to this clause should be repealed. The House having agreed to these resolutions, and the bill being brought in accordingly, another petition was presented by several noblemen, gentlemen, freeholders, and other proprietors, owners, and possessors of coppices and woodlands, in the West Riding of Yorkshire, alleging that a permission to import American bar-iron, duty free, would be attended with numberless ill consequences, both of a public and of a private nature — specifying certain hardships to which they, in particular, would be exposed — and praying that, if the bill should pass, they might be relieved from the pressure of an Act passed in the reign of Henry VIII., obliging the owners of coppice woods to preserve them under severe penalties, and be permitted to fell and grub up their coppice woods, in order to a more proper cultivation of the soil, without being restrained by the fear of malicious and interested prosecutions.

In consequence of this remonstrance, a clause was added to the bill, repealing so much of the Act of Henry VIII. as prohibited the conversion of coppice or underwood into pasture or tillage. It then passed through both Houses, and received the royal sanction.

As there was not time, after this affair came upon the carpet, to obtain any new accounts from America, and as it was thought necessary to know the quantities of iron made in that country, the House presented an address to his Majesty, desiring he would be pleased to give directions that there should be laid before them, in the next session of Parliament, an account of the quantity of iron imported from the American colonies, from Christmas, in the year 1749, to the 5th day of January, in the year 1756, each year being distinguished.

In 1765 an Act was passed allowing our American colonies to ship their iron for Ireland.

As it began to be seen that our true interests consisted in giving some protection to the iron foundries in England, which had arisen by individual interest alone, an Act of Par-

liament was passed in 1769 for discontinuing, upon the exportation of iron in foreign ships, the drawbacks of such parts of the duties payable thereon as exceeded the duties payable upon iron imported in British ships. In this year the importation of iron from Russia alone amounted to upwards of 34,000 tons. To such an extent, through the fostering care first given by Peter the Great, had the iron mines arrived in Russia, that they materially injured the sale of the Swedish iron, from whence, much less than a century before, they used to import considerable quantities into Russia. Such are the effects to be produced when governments wisely patronise national objects of improvement and industry.

The American war breaking out in 1775, a formidable rival, as then considered, to our iron trade was removed, and soon after the close of that war the increase of our trade, and the extension of our manufactures, created an additional consumption of iron in the country; and although we had powerful competitors in Russia and Sweden, yet our furnaces, with the agency of the steam-engine, were producing an annual increase, by manufacturing iron with pit-coal instead of charcoal.

EXPORTS OF IRON FROM THE AMERICAN PLANTATIONS.

Years.	Tons.
1717 and 1718, together - - -	7
1729 to 1735 average - - -	2,111
1739 — 1748 „ - - - -	2,423
1750 — 1755 „ - - - -	3,305
1761 — 1776 „ - - - -	4,045

IMPORTS OF IRON.

Years.	Tons.
1711 to 1718 average - - - -	1,732
1729 — 1738 „ - - - -	2,312

No further returns were published.

CHAP. V.

GREAT BRITAIN.

BEFORE we proceed to detail the vast results in the iron trade, consequent upon the use of pit-coal, aided by the powerful assistance of the steam-engine, it will be desirable to take a retrospective view of the means hitherto employed for blowing the furnaces.

The machine first employed for this purpose was a pair of leather bellows, worked by the hand; but when it became necessary to smelt iron in large quantities, the size and number of the bellows were increased. Two pairs of bellows were so connected, by means of a lever, that the one pair shut when the other opened. The handle of each pair was successively moved by two cogs, placed at right angles to each other on the horizontal axis of a water-wheel, so that, during the revolution of the wheel, one of the cogs shut one pair of bellows, and forced the included air into the furnace, while the other, which at this instant opened, was shut by the action of the other cog, and thus discharged its contents into the furnace. By this means a continued blast was kept up, excepting a trifling pause when the motion was changed.

Another engine, called the water blowing machine, has been used for producing a strong blast. It has been pretty generally adopted on the Continent, but does not seem to have come into use in this country. A current of water is made to pass through a kind of cullender, placed in the open air, and perforated with a number of triangular holes. The water descends through these apertures in many small streams, and by exposing a great surface to the atmosphere, it drags along with it an immense quantity of air, and is conveyed

through a tube till it dashes against a stone pedestal inclosed in a large vessel. The mixture of air and water which falls upon the pedestal is dispersed in every direction — the air is separated from the water — it ascends to the upper part of the vessel, and rushes through a pipe to the furnace, while the water descends through apertures at the bottom of the vessel.* It is proper to observe, however, that, as by this method the air was loaded with moisture, it was necessary to make the condensing vessel as high as conveniently could be, that the air might arrive at the furnace in as dry a state as possible.

Machines of such a description might have been sufficient for smelting iron, when charcoal was used for fuel; when, from the small quantity of air that was then requisite for blast, whether from the great inflammability of the fuel, or the smallness of its capacity, the manufacturer had more frequently felt the effects of over-blowing than under-blowing his furnace; but now, when coal began to be used, it became necessary to construct machines formed of the most durable materials, and capable of affording a powerful and constant blast.

The earliest contrivance of this kind was a forcing pump, worked by a water-wheel or a steam-engine; and it would appear that the first cylinders — at least, of any magnitude — were erected at the celebrated Carron Iron Works, in the year 1760, by Mr. John Smeaton, soon after these works (which, in a few years, became amongst the most famous in Europe †) had been established by the projector, Dr. Roebuck, and other parties.

* Franciscus Tertius de Lanis ("Magister Nat. et Artis," lib. 5. cap. iii.) observes, that he has seen a greater wind generated by a machine of this kind than could be produced by bellows ten or twelve feet long.

† The Carron Works consist of five blast furnaces, sixteen air furnaces, a clay mill for grinding clay and making fire bricks for the use of the said furnaces, an engine that raises four tons and a half of water at one stroke, and, on an average, draws seven strokes in a minute. This engine goes in time of drought, and consumes sixteen tons of coal in twenty-four hours. Besides the coals consumed by this engine, there are 120 tons burnt every day in the works, and by the inhabitants belonging to them. Besides the air furnaces there are three cupola furnaces, that go by virtue of the blast furnaces, by pipes conveyed from the machinery of the blasts: their business is much the same with the air furnaces. There are also four boring mills for boring

According to the custom of the times, the operation of blowing was at first performed by large bellows, moved by means of a water-wheel. Pit-coal was the stable fuel in use, it having been very generally applied, since the year 1750, as a substitute for charcoal in the blast furnace, but the scanty supply of air, and its want of density, seldom permitted the produce of the furnace to exceed ten or twelve tons weekly; and frequently, in summer, the quantity was reduced even below this. The Carron Company collected immense quantities of charcoal, and they found that their blast was much better calculated for the operation of smelting with it, than with the uninflammable pit-coal obtained in their neighbourhood. Experience, however, gradually unfolded means of adapting machinery better calculated to the nature of the coal fuel; more powerful wheels were constructed, the bellows were abandoned, and, in their place, large iron cylinders were introduced.

These cylinders were four feet six inches diameter, exactly fitted with a piston, moved up and down by means of a water-wheel. In the bottom of the cylinder is a large valve, like that of a bellows, which rises as the piston is lifted up, and

guns, pipes, cylinders, &c. One of the boring mills is adapted for turning the guns on the outside—they have likewise smiths' forges, for making the largest anchors and anvils, as well as small work of various kinds; besides a forge for making malleable iron, and a plating forge, also a forge for stamping iron, the hammer of which, with the helve, are both of cast metal, and weigh a ton and a half.—*Sir J. Sinclair's Statistical Account of Scotland*, 1792.

Nobody is admitted to view the works on Sundays, except those who are properly recommended, or known to be worthy of attention. Mr. Burns, the Ayrshire poet, not knowing, or not attending to, this regulation, made an attempt to be admitted, without discovering who he was, but was refused by the porter. Upon returning to the inn at Carron, he wrote the following lines upon a pane of glass, in a window of the parlour into which he was shown:—

"We cam na here to view your warks
In hopes to be mair wise;
But only, lest we gang to hell,
It may be nae surprise.

"But when we tirl'd at your door,
Your porter dought na bear us;
So may, should we to hell's yetts come,
Your billy, Satan, sair us."

Ibid. 1797.

thus admits the air into the cavity of the cylinder below. Immediately above the bottom is a tube which goes to the furnace, and as it proceeds from the cylinder, is furnished with a valve opening outwards. Thus, when the piston is drawn up, the valve in the bottom rises, and admits the air that way into the cylinder, while the lateral valve shuts, and prevents any air from getting into it through the pipe. When the piston is thrust down, the valve in the bottom shuts, while the air being compressed in the cavity of the cylinder, is violently forced out through the lateral tube into the furnace.

There were four of these large cylinders applied to blow the furnace, and so contrived that the strokes of the pistons, being made alternately, produced an almost uninterrupted blast. The pumps being worked alternately by a water-wheel having four cranks upon its axis, each of which moved the piston of a cylinder, which had a stroke of four feet six inches, some little intermission could indeed be perceived, but it was too trifling to produce any sensible effect on the furnace. Even this could have been prevented by means of a large reservoir, into which all the four cylinders might discharge their blast.*

* The situation and singular construction of the Devon Iron Works, begun in July, 1792, merit the attention of the curious in mechanics and architecture. A steep bank rises more than fifty feet above the level of the river, and is composed of a rock, or very thick stratum of freestone, very dry, and uniform in its texture, and almost free from cracks and fissures. Instead of the usual method of building with stone and lime, the several parts of the works have been formed in this bank by excavations made in the rock. Two furnaces, which are each above forty feet high and fourteen feet diameter, and also the spacious arches which give access to the workmen, at the bottom of the furnace, to draw off the liquid metal and slag, are cut out of the rock. The roof which covers the casting-house, a room seventy feet long, fifty feet wide, and twenty-three feet high, is supported by the sides of the quarry and the solid pillars of the rock, that were left for this purpose in making the excavation. In like manner is formed the engine-house and its apparatus, which is intended to supply the two furnaces with wind, by throwing, at each vibration of the engine, a sufficient quantity of air out of a large cylinder into a long gallery, or close mine, formed in the rock. This magazine of wind will contain above 10,000 cubic feet of air, much condensed by the power of the engine, as the gallery is very closely shut up, and made air-tight, having only two apertures,

A large column of air, of triple or quadruple density, was thus obtained, and effects equivalent to these great improvements followed. The same furnace, that formerly yielded ten and twelve tons weekly, now, sometimes, produced forty tons in the same period, and, on the average, in one year, 1500 tons of metal.

In situations where a fall of water could not be obtained, steam-engines were employed to work the pumps; but as these machines were then only single, the piston descending by the pressure of the atmosphere, it was necessary to have some contrivance for producing a continued stream of air during the descent of the piston. This object was effected by receiving the air into a regulating cylinder, of the same size as the blowing cylinder, and furnished with a piston loaded with heavy weights. As every stroke of the engine would pump into this cylinder twice the quantity of air that would pass through the nose pipe into the furnace in the same time, the air raised the loaded piston of the regulating cylinder, and during the time that the engine ceased to act, the weight of the regulating piston forced the air into the furnace. This method of regulating the blast, which continued in general use for many years, was superseded by the water regulator, and by the double-acting blowing cylinder, wrought by a steam-engine of Watt and Boulton's construction.

The iron-trade began immediately to revive on the application of pit-coal, aided by powerful engines, and its progress in England and Wales was truly astonishing. The general use of pit-coal, most unquestionably, occasioned an earlier relinquishment of many of the charcoal works than would otherwise have been the case, but the manufacture had so much increased as to render this an object of trifling importance.

The following statement shows the manufacture of charcoal pig-iron in England and Wales in the year 1788:—

one to receive the supply of air from the air-pump, and the other to admit a pipe that conducts the condensed air to blow the two furnaces.—*Sir J. Sinclair's Statistical Account of Scotland,* 1793.

	No. of Fur.	Tons at each.	Total in each county.
Gloucestershire - - -	4	650	2,600
Monmouthshire - - -	3	700	2,100
Glamorganshire - - -	3	600	1,800
Carmarthenshire - - -	1	400	400
Merioneth - - - -	1	400	400
Shropshire - - -	3	600	1,800
Derbyshire - - -	1	300	300
Yorkshire - - - -	1	600	600
Westmoreland - - -	1	400	400
Cumberland - - -	1	300	300
Lancashire - - -	3	700	2,100
Sussex - - - -	2	150	300
Total - -	24		13,100

Average produce from each furnace - - 545 tons.

In the year 1740 the quantity of charcoal pig-iron manufactured in England and Wales amounted to 17,350 tons; in 1788 the quantity was 13,100 tons—being a decrease in that period of 4,250 tons, attributable chiefly to the decrease of wood, but also, as we have before stated, to the use of pit-coal as a substitute for charcoal in the furnace.

In the year 1788 the manufacture of coke pig-iron was as follows:—

	No. of Fur.	Make of each.	Total in each county.
Shropshire - - -	21	1,100	23,100
Staffordshire - - -	6	750	4,500
Derbyshire - - -	7	600	4,200
Yorkshire - - - -	6	750	4,500
Cumberland - - - -	1	700	700
Cheshire - - - -	1	600	600
Glamorganshire - - -	6	1,100	6,600
Brecknockshire - - -	2	800	1,600
Staffordshire, 3 new furnaces expected to be in blast the same year - - - -	3	800	2,400
Total - -	53		48,200

	Tons.	cwt.	qr.
Average produce at each furnace - -	909	0	0
Total of charcoal pig-iron - - -	13,100	0	0
Ditto of coke pig-iron - - -	48,200	0	0

— being a total of 61,300 tons of pig-iron manufactured in England and Wales. At the same period there were erected, and in blast, in Scotland, in the West Highlands:—

			Make of each.	Total in each county.
Goatfield - -	Charcoal fur.	1	700	700
Bunawe - -	- -	1	700	700
There were also —				
Carron - -	Coke fur.	4	1,000	4,000
Wilsontown, or Cleugh	- -	2	800	1,600
	Total - -	8		7,000

—being a total of 7000 tons of pig-iron manufactured in Scotland,

Average produce at each furnace - - 875 tons.

Furnaces.		Tons.
77	Total quantity of pig-iron made in England and Wales	61,300
8	Ditto, ditto, in Scotland - - - -	7,000
85		68,300
59	Annual quantity manufactured preceding the introduction of pit-coal for furnace fuel - - - -	17,350
26	Total increase - - -	50,950

As the period of 1788 or 1790 may be considered a new era in the history of the manufacture of iron, arising from the more general use by the iron masters, of the double power engine of Mr. Watt, it may prove interesting to give a short account of the introduction of this most valuable machine.

Notwithstanding various attempts by the Marquis of Worcester*, and others, to construct a steam-engine, no machine

* The Marquis of Worcester was the inventor of the steam-engine, or a machine in which the elastic force of steam was proposed as the first mover in raising water. In his "Century of Inventions," a work published in 1663, he

of this kind appears to have been completed and applied to actual use, before the invention of Capt. Thomas Savery, treasurer to the commissioners of sick and wounded. In a pamphlet entitled "The Miner's Friend," published in 1696, he describes a steam-engine, in which water is raised not only by the expansive force of steam, but also by its condensation, the water being raised by the pressure of the atmosphere into receivers, from which it is forced to a greater height by the elastic force of the steam. After having erected several of these engines, Savery took out a patent, in 1698, for a new invention "for raising water, and occasioning motion to all sorts of mill work." In June, 1699, he exhibited a working model to the Royal Society, who printed in their Transactions for that year a drawing and description of it; but the most complete account of it appeared in a small pamphlet of eighty-four pages 12mo., which Mr. Savery published in 1707, under the title of "The Miner's Friend, or an Engine to Raise Water by Fire Described; and the manner of fixing it in mines, with an account of the several uses it is applicable unto, and an answer to the objections made against it." This book was separately addressed to King William III., to whom the engine had been shown at Hampton Court.

Various engines on the principle of Mr. Savery's have been erected since his time, and various improvements made on the original construction; amongst others by Dr. Desaguliers, but before his improvements were proposed, a very important invention had been made by Mr. Thomas Newcomen, an ironmonger at Dartmouth. There is reason to believe that this ingenious workman was occupied in the improvement of the steam-engine as early as Mr. Savery. Switzer, indeed, who was a friend of Savery's, and therefore not likely to make any statement injurious to his reputation, distinctly informs us that he had good authority for stating that Newcomen was as early in his invention as Savery, but that the latter, being nearer the Court, obtained his patent before the other knew of

has described this engine, in No. 68., and he has again referred to it in Nos. 98, 99, and 100. He has also left behind him, what he calls "A Definition of his Engine," the only copy of which is preserved in the British Museum.

it, on which account Newcomen was glad to come in as a partner in the patent, which was granted to them in 1705.

Desaguliers, however, has given a different account of the matter, and as the passage contains some interesting details, we shall give it in his own words:—"Thomas Newcomen, ironmonger, and John Calley, glazier, of Dartmouth, made the several experiments in private, and having brought the engine to work with a piston, &c., they, in the latter end of the year 1711, made proposals to draw the water at Griff, in Warwickshire; but their invention meeting not with reception, in March following, through the acquaintance of Mr. Potter, of Bromsgrove, in Worcestershire, they bargained to draw water for Mr. Bach, of Wolverhampton, where, after a great many laborious attempts, they did make the engine work; but not being either philosophers to understand the reasons, or mathematicians enough to calculate the powers, and to proportion the parts, very luckily, by accident, found what they sought for. They were at a loss about the pumps, but being so near Birmingham, and having the assistance of so many admirable and ingenious workmen, they so soon came to the method of making the pump valves, clacks, and buckets, whereas they had but an imperfect notion of them before."

The engine thus constructed has received the name of the atmospheric engine, in consequence of the power which is employed, being only the weight of the atmosphere, the steam exerting no force whatever, either upon the surface of the water, or upon the piston, and having no other functions to perform but that of forming a vacuum.

But to the great and comprehensive genius of the late Mr. Watt are we indebted for those improvements, which have rendered the steam-engine the present powerful agent of our iron works and other manufactures. When Mr. Watt's attention was turned to the subject of steam, in 1759, it was then an effective and useful machine, and was used to a considerable extent in the mines and manufactories of the kingdom; but though it was then an effective machine, it was a

very imperfect one, and required for its improvement all the energies of a mind deeply imbued with mechanical and chemical knowledge.

Mr. James Watt was a maker of mathematical instruments at Glasgow, and being a man of a truly philosophical mind, and well conversant with all branches of science, he was in the habit of associating with the most celebrated scientific men at that time in Scotland, particularly with Dr. Black, Dr. Roebuck, and Dr. Robison. In the year 1761 or 1762, Mr. Watt had constructed a model, with which he showed the practicability of what is now called the high-pressure engine; but it was not till 1763, when he was repairing a working model of Newcomen's engine, belonging to the college at Glasgow, that his mind was usefully directed to the subject; during this employment, he observed the great loss of steam from the condensation of the cold surface of the cylinder. He made various experiments during the ensuing year to obviate this, but it was not until early in 1765 that it occurred to him, that if a communication were opened between a cylinder containing steam, and another vessel exhausted of air and other fluids, the steam would immediately rush into the empty vessel, and continue to do so till it had established an equilibrium, and if that vessel were kept very cool by an injection or otherwise, more steam would continue to enter, until the whole was condensed. Thus did he discover the great principle of condensation in a separate vessel.

Mr. Watt was so much occupied in other business, that it took him much time to complete his machine, and bring the whole to bear, so that he did not apply for his first patent until 1768, which bears date January 5, 1769, and is for his "methods of lessening the consumption of steam, and, consequently, of fuel in steam-engines."

Soon after his patent was obtained, Mr. Watt became associated with Dr. Roebuck; they proposed establishing an extensive manufactory for such engines under the patent, and Mr. Watt began his first real engine, of eighteen inches cylinder, at Kinneil, near Borrowstownness. This was a sort of experimental engine, and was successively altered and im-

proved till it was brought to considerable perfection. In the details of its construction, the greatest difficulty of all was the packing of the piston, so as to be steam tight, because Mr. Watt's principle did not admit of water being kept upon the piston, to prevent the leakage, as in the old engines.

He found great difficulties in procuring a cylinder sufficiently accurate, until a new method was introduced at Burham foundry, by Mr. John Wilkinson.* In the old method of boring, the instrument which performs the part of cutting the metal was guided in its progress by the incorrect form given to the cylinder by the moulder, and although it insured that every part of the cylinder should be circular, it gave no certainty that the cylinder should be straight. This was quite sufficient for the old engines, but Mr. Watt's engines required greater precision. Wilkinson's machine insured the accuracy required, and if the cylinder was cast ever so crooked, the machine would bore it straight and true.

Dr. Roebuck becoming embarrassed, from the failure of his vast undertaking in the Borrowstownness Coal and Salt Works, was unable to prosecute the manufacture of steam-engines; and, in 1774, disposed of his interest in Mr. Watt's patent to Mr. Matthew Boulton, whose establishment at Soho, near Birmingham, was then the most complete in England, and conducted with the most spirit. A portion of the works was allotted to Mr. Watt, who erected a foundry and the necessary works to carry his invention into effect, on a grand scale.

In consequence of the great loss of time, and the enormous expense necessary for bringing the engine to perfection, Mr. Watt was not able to produce any large engines, as specimens of his invention, until 1774; and found, from the difficulty of introducing them, that the term of his patent was likely to pass away before he should be reimbursed; he, therefore, applied to Parliament for a prolongation of his term, which was granted for twenty-one years, by an Act passed in 1775,

* Mr. Wilkinson was the first who applied steam-engines to blow the furnaces.—*Lord Sheffield's Observations on the Manufactures, Trade, and Present State of Ireland*, 1785.

the period to commence from the expiration of his first patent.

With this encouragement, and with the advantage of Mr. Boulton's assistance in systematising the manufacture of the parts, Mr. Watt soon produced many capital engines, which were erected in Staffordshire, Shropshire, and Warwickshire, and a small one at Stratford, near London, but chiefly in Cornwall; and Messrs. Watt and Boulton granted licenses to use their engines, on securing a third part of the saving in coal, compared with an atmospheric engine performing the same work with coals equal in quality. The amount of this saving was determined by ascertaining experimentally the coals consumed during any number of strokes made by the common and the improved engine. The number of strokes made in any given interval, was ascertained by a piece of machinery called the counter, which was struck at every ascent of the working beam. Two keys of this machine were kept, one by the patentees, and the other by the proprietors; and a traveller, who examined it at stated times, calculated the saving of coal from the number of strokes.*

The regular and increased effects of this very powerful machine were soon felt in most of the iron districts. The produce of the furnaces greatly increased as to the quantity of metal, and as the proprietors of the works became more prosperous, other capitalists were induced to engage in similar undertakings. Another cause also operated at this time, namely, the high price of foreign iron †, and the vexatious

* For three large engines, at Chacewater mine, in Cornwall, the proprietors paid 800*l.* annually, instead of the third of the saving of coal.—*Edinburgh Encyclopædia*, Art., "Steam Engines."

† The iron used at the Cramond Works comes chiefly from Russia and Sweden, upwards of 1,000 tons being imported from the Baltic yearly. The average cost per ton (including customs at 56*s.*, and freight from 8*s.* to 15*s.*) is 17*l.* for Russian, and 18*l.* 10*s.* for Swedish iron; but a very fine kind of the latter, the produce of the famous mine of Dannemora, called Oregrund iron, from the port where it is shipped, comes to 24*l.* per ton. This sort is used solely for making steel. These different kinds of iron are 50 per cent. dearer than they were in 1780, which rapid advance has lately induced the proprietors to erect furnaces at Clyde, near Glasgow, with the view of making bar-iron for

proceedings of the Russians, who imagined that we were completely at their mercy for the necessary supply of iron.* New works were yearly erected, and several furnaces were annually added to those already in blast, and the increase was so considerable that, in the course of eight years, the manufacture of pig-iron was nearly doubled, as will appear by the following returns, which were sent to the chairman of the committee of the House of Commons, on the subject of the coal trade, when Mr. Pitt, in the year 1796, had it in contemplation to add to the revenue by a tax upon coal at the pit-mouth. This, of course, led to a powerful opposition on the part of the manufacturing consumers, and particularly so, as may easily be imagined, in the iron trade. A committee was appointed, witnesses examined, facts collected, and the measure abandoned, as being unwise and impracticable.

Cramond, which they hope will, in a few years, furnish them with sufficient materials, and save the great sums remitted for that article.—*Sir J. Sinclair's Statistical Account of Scotland*, 1791.

* The first considerable rise in foreign iron did not occur till 1796, when it advanced suddenly about 30 per cent. This was the year before the bank restriction, and the rise occurred in consequence of the importation having fallen off, instead of keeping pace with the increasing demand for consumption in this country, and in the rest of Europe, as well as in the United States of America ; and the produce of our mines was at that time comparatively insignificant. Between 1796 and the close of 1800 there was no further advance. But the embargo in Russia in the latter year had the effect of raising the price 10 per cent. more, and an additional duty of about 1*l.* per ton had been laid on the importation, in the interval between 1796 and 1798. The advance altogether, therefore, including the new duty, was nearly 10*l.* per ton since 1795; and this great advance operated as a sufficient premium for applying increased capital to the production of iron in this country, and for bringing into operation for that purpose, all the powers of machinery, which was then undergoing a rapid improvement. Thenceforward the produce of iron in this country proceeded so rapidly, that with the aid of further duties, amounting almost to a prohibition of importation, it not only kept pace with the increasing demand, but has eventually nearly superseded the use of foreign iron in this country, and has furnished a surplus for exportation. The price of foreign iron, accordingly, fell almost progressively from 1801 till the close of the war.—*T. Tooke's High and Low Prices.*

CHESTER.

Names of Furnaces.	No. of Fur.	Excise return. T.	c.	Sup. quanty. Tons.	Exact return. T.	c.
Apedale - -	1	2,100	0	1,000	728	10
Silverdale - -	1	2,600	0	1,200	1,230	0
CUMBERLAND.						
Bearpost - -	1	2,080	0	1,200	240	0
Dudden - -	1	1,664	0	400	325	0
Newland - -	1	700	0	700	700	0
Backbarrow - -	1	700	0	700	769	0
DERBY.						
Dale Abbey - -	1	474	0	474	443	0
Mersey Park - -	1	728	0	728	728	0
Buttersby - -	1	936	0	936	936	0
GLOUCESTER.						
Flaxley - - -	1	360	0	360	360	0
Forest of Dean -	1	20	0	20	20	0
HEREFORD.						
Abbey Tintern -	1	70	0	70	70	0
Bishopwood - -	1	500	0	500	947	0
Cornbrook - -	1	1,000	0	1,000	482	0
Bringwood - -	1	500	0	500	250	0
Leighton - -	1	780	0	780	780	0
LINCOLN.						
Renishaw - -	2	500	0	500	705	0
SALOP.						
Old Park - -	3	11,332	10	6,240	5,952	0
Horschay - -	1	4,927	10	2,080	1,458	4
Lightmoor - -	3	8,946	0	6,240	3,498	15
Coalbrooke Dale -	3	7,175	0	4,162	2,659	11
Madeley Wood -	1	3,777	10	2,080	1,856	8
Jackfield - -	2	7,086	0	4,160	1,820	0
Benthal - -	1	2,367	10	1,600	1,334	0
Willey - - -	1	3,702	10	1,600	1,554	10
Brosely - -	1	1,775	0	1,400	1,076	10
Kepley - - -	3	7,590	0	6,210	5,068	19
Sondshill - -	2	4,730	0	3,400	3,367	0
Donnington Wood	2	4,720	0	4,160	3,323	0
SUSSEX.						
Ashburnham - -	1	172	15	173	173	0

WALES (SOUTH).

Names of Furnaces.	No. of Fur.	Excise return. T.	cwt.	Sup. quanty. Tons.	Exact return. T.	cwt.
Clydach - -	1	1,820	0	1,820	1,625	0
Blaendare - -	1	1,404	0	1,404	1,500	0
Blaenavon - -	3	5,460	0	5,460	4,318	0
Sirhowy - -	1	1,820	0	1,820	1,930	0
Beaufort - -	1	1,560	0	1,560	1,660	0
Penyca, or Ebbervale	1	1,560	0	1,560	397	0
Hirwain - -	1	1,400	0	1,400	1,050	0
Melinicourt - -	1	648	0	648	503	0
Ennisygedyr -	1	1,352	0	1,352	800	0
Caerfilly - -	1	600	0	600	695	0
Cyfarthfa - -	3	6,000	0	6,000	7,204	0
Plymouth - -	1	2,000	0	2,000	2,200	0
Pendarron - -	2	4,000	0	4,000	4,100	0
Dowlais - -	3	4,100	0	5,400	2,800	0
Llanelly - -	1	1,664	0	1,664	1,560	0
Neath Abbey -	2	3,120	0	3,120	1,759	0
WALES (MIDDLE).						
Dovey - - -	1	200	0	200	150	0
WALES (NORTH).						
Ruabone - -	1	1,560	0	1,560	1,144	0
Brymbo - -	1	884	0	—	——	
Brymbo-gate - -	0	728	0	—	——	
Ponyrron - -	0	1,498	0	Lead Work.	——	
Pentrobn - -	0	1,560	0	Ditto.	——	
WALES (WEST).						
Carmarthen - -	1	1,056	0	1,056	290	0
STAFFORD.						
Level - - -	1	1,560	0	1,560	1,391	0
Brierly - - -	1	1,300	0	1,300	1,046	10
Duffield - -	2	2,600	0	2,600	2,526	0
Bilston - -	2	2,340	0	2,340	1,429	0
Bradley - -	3	3,640	0	3,000	1,920	0
Grave-yard - -	1	1,260	0	1,336	213	0
Dudley Port - -	1	1,040	0	1,040	869	0
Tipton - - -	2	2,080	0	2,080	2,203	0
Gospel Oak - -	1	——		—	1,613	0
YORK (LEEDS).						
Bowling - -	2	2,000	0	2,000	2,000	0
Wibsey Moor -	2	2,000	0	2,000	2,500	0
Shelf - - -	1	1,000	0	1,000	1,140	0
Birkenshaw - -	1	780	0	780	846	0

YORK (SHEFFIELD).

Names of Furnaces.	No. of Fur.	Excise return. T.	cwt.	Sup. quanty. Tons.	Exact return. T.	cwt.
Chesterfield -	- 1	940	0	940	940	0
Little Brampton	- 2	1,800	0	1,800	1,560	0
Winger Worth	- 1	1,274	0	1,274	1,274	0
Stavely -	- 1	1,000	0	1,000	761	1
Park - -	- 1	1,092	0	1.092	853	0
Chapel - -	- 1	1,456	0	1,456	1,456	0
Horncliffe -	- 2	1,092	0	1,092	712	0
Elshar - -	- 1	800	0	800	950	0
Bretton - -	- 1	250	0	220	250	0
Holmes - -	- 3	6,000	0	6,000	2,000	0
Total	- 104	167,312	0	133,965	108,973	0

SCOTLAND.

Carron - -	- 4	5,200	0	5,200	5,616	0
Wilson Town	- 2	——		2,080	2,080	0
Muirkirk -	- 2	——		3,120	2,878	0
Clyde - -	- 3	——		3,640	2,216	0
Omoa - -	- 2 }	——		3,000	2,396	0
Devon - -	- 2 }					
Goatfield, charcoal	- 1	——		1,600	300	0
Bunawe, ditto	- 1	——		—	600	0
	17	5,200	0	18,640	16,086	0
	104	167,312	0	133,965	108,993	0
	121	172,512	0	152,605	125,079	0

Average produce of each of the English and Welsh furnaces 1,048 tons per ann.
Ditto of the Scotch furnaces - - - - - - - 946 „

The demand for iron articles of all kinds in this country not only continued unabated after the period of 1796, but kept increasing in a greater ratio than formerly, so that, in the short space of five years, situations were occupied for nearly fifty additional furnaces, or additions made to established works of that extent. In 1801 and 1802 it was ascertained that the following new furnaces were either building, or actually in blast, in England, Wales, and Scotland: —

	Furnaces. In blast.	Furnaces. Building.
Silverdale	1	0
Snidshill	2	0
Wibsey Moor	1	0
Kittry	1	0
Madily Wood	1	0
Burnit's Leason	1	0
Newcastle, Staffordshire	0	1
Cyfarthfa	1	0
Llanelly	1	0
Sirhowy	1	0
Beaufort	1	0
Plymouth	1	0
Union	0	1
Aberdare	0	3
Tipton	1	1
Bloomfield	0	1
Longacres	0	1
Wednesbury	1	1
Coleford	1	0
Jackfield	1	0
Old Park	0	1
Donnington Wood	0	1
Duffield	1	0
Gornall Wood	1	0
Brierly Hill	1	0
Near Wolverhampton	0	1
Dudley Wood	0	5
Billingsly	0	1
Newcastle-upon-Tyne	0	2
Bilston	1	0
	20	20
SCOTLAND.		
Muirkirk	1	0
Glenbuck	1	0
Calder	0	2
Markinch	0	2
Shotts	0	1
	2	5
England and Wales	20	20
	22	25

Making the total number of new furnaces in blast and building in Great Britain forty-seven.

The great increase in the manufacture of iron attracted the notice of government, and, in the year 1797, Mr. Pitt, then Chancellor of the Exchequer, proposed laying a duty of 20*s.* per ton on pig-iron, but, after full consideration, he abandoned the idea. Lord Henry Petty, however, revived the subject in the year 1806. He proposed to levy a duty of 40*s.* per ton on pig-iron, as a war-tax, and submit its various processes to the constant inspection of Excise officers. There were, at this time, 133 iron works in Great Britain, the proprietors of which met in the several districts, and deputed fourteen of their body to assemble in London, and arrange the information submitted to the committee of the House of Commons on the bill for imposing this tax; showing its impolicy and ruinous tendency on a manufacture which is essential to the success of almost all branches of British industry.

The following is an abstract of a statement which the deputation prepared of the several furnaces, which, in the spring

of the year 1806, were working with cokes of pit-coal, and charcoal, in England, Wales, and Scotland.

No. of Works.	Counties.	No. of Furnaces. In blast.	Out.	Total.	Tons pig-iron made ann.	Av. tons p. Furnace.
4	Cumberland - -	4	0	4	1,491	373
11	Derbyshire - -	12	6	18	10,329	861
2	Gloucestershire -	2	1	3	1,629	815
3	Lancashire - -	2	2	4	2,500	1,250
1	Leicestershire -	0	1	1	—	—
3	Monmouthshire -	3	0	3	2,444	815
19	Salop - - -	28	14	42	54,966	1,963
25	Staffordshire -	31	11	42	49,460	1,595
14	Yorkshire - -	23	4	27	26,671	1,160
82	Total in England -	105	39	144	149,490	1,424
25	South Wales - -	36	11	47	75,601	2,100
3	North Wales - -	3	1	4	2,075	692
12	Scotland - -	18	9	27	23,240	1,291
122	Total coke furnaces in Gt. Britain -	162	60	222	250,406	1,546
11	Old charcoal furnaces still in use in different counties -	11	0	11	7,800	709
133	Total Gt. Britain -	173	60	233	258,206	—

Making the average annual produce of each of the 162 coke furnaces in blast 1546 tons.*

'By this document it appears that, of the 233 furnaces then erected, sixty were out of blast, and that the remaining 173

* But this average will not show the effect produced at those works where powerful engines were erected; it will, therefore, be desirable to notice, that at some of these, as at Cyfarthfa, in South Wales, the average per furnace is as high as 2,615 tons per annum, while, in twenty-three others, the quantity falls below 500 tons, being, at Dovey, in North Wales, stated at only 150 tons per annum.

Seventeen of these works make 4,000 tons each, or upwards, of which the six largest are—

Cyfarthfa, in South Wales - -	10,460	tons per annum.
Blaenavon - - - - - -	7,846	"
Penydarren - - - - -	7,803	"
Old Park, Salop - - -	8,359	"
Kepley - - - - - -	7,510	"
Carron, Scotland - - -	7,380	"

furnaces produced the astonishing quantity of 258,206 tons of pig-iron—being an increase in ten years, from 1796, of no less than 133,127 tons per annum; and during the same period, there were erected, as we have already seen, to the year 1802, forty-seven new furnaces, and, subsequently, up to 1806, sixty-five additional ones, making, however, some allowance for the furnaces, if any, which were out of blast in 1796.

It was calculated that 95,000 tons were converted into bars and other descriptions of iron; that the capital employed in the manufacture was five millions sterling, and that it furnished employment to 200,000 persons.

When Lord Henry Petty proposed this tax on pig-iron he stated—"This tax was formerly in contemplation, and as the object is now greatly extended in use, and as 130,000 tons was the quantity then manufactured, I apprehend that the quantity may now be estimated at 250,000 tons, which, at 40*s*., will be 500,000*l*. Upon this head there will be countervailing duties on foreign iron, and a fair drawback will be allowed. This tax will be under the Excise."

An account was moved for, and ordered, of the quantity of iron consumed by the Ordnance, and of the iron purchased for the Navy. This account was accordingly presented to the House by Mr. Vansittart, and a copy, embodied in an account, headed "Estimate of the Net Produce of the Duty upon Iron," was transmitted to the deputies of the iron trade, who replied to it by counter statements.

Upon the second reading of the bill, Sir John Wrottesley asked, "Whether anything was proposed to be done to obviate the difficulty of giving a sufficient drawback to the manufacturers engaged in the export trade? A number of gentlemen in town, whose opinions deserved the attention of the House, thought the proposed drawback insufficient, as it seemed the utmost to be allowed did not exceed 4*l*. per ton. The deductions on account of the Ordnance and Naval stores would be considerable."

Lord Henry Petty stated "the amount of deduction for iron used in the Ordnance and for the Navy department to be

altogether 51,460*l.*; the drawbacks on foreign iron 13,770*l.*; that on British iron 123,000*l.*—making a total, with 5000*l.*, the estimated expense of the collection, of 193,000*l.*, to be deducted from the produce of the tax. The average of the drawback was 4*l.* a ton."

Mr. Vansittart observed, "that 4*l.* per ton had been calculated upon as an average, and not as the highest allowance."

The bill was then read a second time and committed. When the bill came under discussion, the opposers of the measure contended that it had hitherto been our uniform policy not to tax articles that were the staple commodities of the country, such as iron, coals, or wood. That of all these commodities iron might be considered the most important, and any tax upon that article must be injurious to the general interest, but the operation of this tax particularly so. It was proposed to lay an equal duty on iron of all qualities, although there was a variation of at least 50 per cent. in the value of different kinds. How, therefore, could this proposition be reconciled with the principles of justice? The uses of iron were so multiplied, that it was probable they had not been taken into consideration. With respect to iron of the lowest quality—in the article of iron railways from mines, the operation of the tax would increase the expense of such railways 700*l.* a mile—an expense which would almost amount to a prohibition of them. It had been found desirable to abolish wooden railways for the purpose of substituting iron ones—an object which this tax must in a great measure defeat. Yet it would, even then, be felt most severely in the construction of those wooden railways. The ramifications of injury that the tax would cause were innumerable. On a moderate calculation, it would raise the price of coals 1*s.* per ton. The quantity imported into London within the year exceeded a million of chaldrons. Thus, from this small advance, 50,000*l.* would arise. The utmost at which the friends of the tax computed its annual amount was 300,000*l.* The opponents of it thought it would not be so much. The additional charge, therefore, merely on

coals brought to London, came to a sixth of the whole produce of the tax.

Another baneful effect of the tax would be, that, by its operation on the machinery of our manufactures, horses would be substituted in many cases, and this at a time when we were paying millions annually to the continent for foreign grain. At the present moment iron was applied to purposes for which large timber would then be used. Would it be wise to increase the demand for timber of this description, at a period when it was already so alarmingly scarce? With regard, to iron of the higher and finer kind, in many manufactures it had to pass through three or four different hands. In each of these stages an augmentation of price would take place.

With respect to the tax as it affected the manufactures, the agriculture of the country, and the comforts of the poor, it would raise the price of many of those manufactures in which iron was principally employed 12½ per cent., and in some cases much higher. This was a most serious consideration to the country, when the manufactures of Flanders, of Prussia, and of Styria, were able to come into competition with us in the foreign markets, and even to undersell us in the coarser articles.

The seats of the great manufacture of iron ware had been seriously affected by the wars on the continent, and this tax would have on them the most injurious effects. Its influence on agriculture would also be pernicious; it would tend to give the grazing farmer, who made less use of horses and implements of iron, great advantages over the arable, and thus would throw an undue proportion of the country into pasture. It would press heavily also on the poor—iron was a necessary part of most of the tools which they employed, and thus the very implements which they used might be placed almost beyond their reach.

The effects of this measure must inevitably be to throw a gloom on the spirit of our manufactures—to cut up those very resources to which the country would have to look for its protection and defence, and to deprive of bread very nu-

merous classes of our industrious poor. It would have the most injurious effects on a very large proportion of the inhabitants of Birmingham, which place had been formerly called the toy-shop of Europe; but since the convulsions that had taken place on the Continent, the demand for those articles of curious and elegant manufacture had entirely ceased, and goldsmiths and silversmiths were now converted into blacksmiths. Even in their articles, Germany and America had now begun to enter into competition with us. The manufactures of these countries had received every encouragement from their different governments, and surely our own manufactures were equally entitled to the fostering care of our own legislature.

The difficulties attending the proper allowance of drawbacks were very great; the orders for the foreign market were all made up in large casks, and it would be necessary to submit them to the inspection of the exciseman; that the whole would be vexatious in the extreme. That if the rising manufacture of unwrought iron remained untouched, it would prove a resource of incalculable riches to the country; but, should it be strangled in its infancy by the hands of the exciseman, the country would have reason to curse the hour when such a tax had been imposed. It was by our trade and manufactures that we were enabled to hold such a distinguished rank among the nations of the world; and, while these were not discouraged by our own government, we had no reason to fear that the efforts of Buonaparte would ever be able to drive them from the markets of Europe. They would continue to find their way into every part of the habitable globe.

It was acknowledged that the situation of the Minister of Finance had, of late, every year grown more and more difficult, since almost every object of taxation had already been resorted to. It had, therefore, become difficult to select a tax that was not liable to some objections, but the present tax appeared peculiarly objectionable. It had been well observed, that the possession of iron was one of the great grounds of distinction between civilised and barbarous society; and

in the same proportion that this country had improved in manufactures and civilisation, the manufacture of iron had been extended and improved, and had found its way, by numerous meandering streams, into every department of civil life.

The number of those employed in producing the raw material, and of those who afterwards wrought it up into every article of utility or elegance, was very great; these were mostly men of athletic make and great bodily vigour, which was a consideration of no small consequence in viewing the general utility of a manufacture, since it had been justly said, that too many of our manufactures tended to deteriorate the physical constitution, and produce a feeble and degenerate race of men, without spirit or ability to defend their rights. In this view alone the manufacture of iron, in all its branches, was highly deserving of encouragement, and any obstruction given to its progress greatly to be deprecated.

It was computed that between 400,000 and 500,000 persons were engaged in the various branches of the manufacture; and when it was considered how much every one of them contributed to the revenues of the state, by the produce of his industry, it became a matter of serious consideration whether the sum proposed to be raised by this tax would not be more than countervailed by those defalcations in other parts of the public revenue, which would arise from the discouragement given to the iron manufacture by the present tax.

This tax had been proposed to the House ten years ago, and had then, upon full consideration, been withdrawn. It was then proposed to lay on a duty of only 20*s.* per ton, but the late Chancellor of the Exchequer saw reasons, at that time, to decline the prosecution of the measure; it was one of the characteristics of that great man (Mr. Pitt) candidly to give up any measure which, on investigation, he found inexpedient, without dreading the charge of inconsistency or indecision.

The manufacture of iron had this peculiar recommendation belonging to it, that it had arisen and flourished most in those

parts of the country which Nature seemed to have doomed to everlasting sterility; and, as Mr. Wilberforce observed, "he had never felt a more sensible pleasure in his life than when, after the lapse of a few years, he had returned to a spot once rugged and barren, but then covered by the fruits of human industry, and gladdened by the face of man, in consequence of the introduction of this manufacture."

It was a received principle of taxation that no duty should press upon any article in its rude and early state, since it caused an uniform rise of price in every article into which it was afterwards wrought up. In this instance, though the sum that would enter the Treasury would not be more than 200,000*l.*, yet a tax of nearly a million would be raised from the community at large. This was a prodigal waste of those resources which ought to be husbanded for future demands, and which the public spirit of the country would cheerfully contribute whenever they were called for by the necessity of the times. It was a sound principle of taxation, that every tax should be as little vexatious as possible in its collection, for the tax on the feelings of the subject might be more galling than that on his pocket. The application of the excise to any branch of commercial enterprise was to be regretted; but, in this instance, it would prove more than usually vexatious, from the number of those engaged in the manufacture, from the multifarious variety of the articles, but, above all, from the artisans being hitherto completely unaccustomed to the operation of excise laws. Within the short space of nine years, the manufacture of iron had been more than doubled. The annual produce had then been 100,000 tons, but it had now risen to 250,000; it was, therefore, our duty to foster its progress and not to check it. This tax would cause an increase of price to the amount of 10, 15, and even 20 per cent. The proposed drawback was greatly too small; government had estimated that it would amount to 150,000*l.*, but the manufacturers calculated that 266,000*l.* would be requisite.

It was a fact, that, even at present, some of the German manufacturers were able to furnish their articles cheaper than

they could be produced in this country, and the tax would tend still more rapidly to drive us from the foreign market. There were considerable quantities of iron used in canals, bridges, ship-building, and agriculture, on all which the tax would severely operate. If the requisite sum could be raised in another way, why impose it on a manufacture of universal application? It was said to be an argument in favour of the bill, that it would operate generally; it would certainly operate as a general burden, but it would not be generally productive.

The supporters of the bill, on the other hand, argued that it was a principle of taxation to lay the tax on articles that were most diffusive, and, consequently, would be most productive. It was thought that necessaries ought not to be taxed, and that every thing should fall on luxuries. All the papers before the House showed that the opposition to the bill came from the manufacturers, not the consumers. As to foreign consumption, the tax could have but little effect; it was not the quantity, but the quality, of our manufactures, which was looked to. If we talked of exempting necessaries from taxation, we must give up every resource, and tax nothing.

The use of iron for the purpose of agriculture had been mentioned as an objection to the tax, but the consumption of that article, in this respect, was trifling when compared with its consumption in our West India plantations, where it was used, instead of copper, for boilers and other culinary purposes. The present tax could not affect our articles of hardware in the foreign market, as the demand for those articles did not depend on their price, but arose from their superior quality. In this respect no foreign manufacture was likely soon to rival us.

It had been stated that the iron trade was not yet ripe enough to produce a revenue. If the iron trade had doubled, as it was admitted had been the case within the last ten years, it was impossible to deny that it was a fit object for taxation, considering the state of the country, and the necessity there was for making every article contribute to the present exi-

gencies, considering the high duty on malt and even on salt; and considering the great and extraordinary length to which the income tax had been carried this year, it was rather matter of surprise that the present tax had not sooner been thought of. If it could be made out that, by proper drawbacks being allowed, no loss would arise to our foreign market, and at the same time that a great increase would thereby arise to the revenue, of probably 300,000*l.* or 400,000*l.*, it would require some reasoning stronger than had been yet heard, to prove the tax ought not to be adopted. The objections to the Excise would have been perfectly applicable to the first introduction of the Excise laws into this country. The gentlemen now sought to be put under the regulations of Excise would not have the same necessity for frequent visits from the officers as others had.

To show that the excellence of the manufacture was that which recommended it to foreign markets, the great fluctuation which had taken place in the prices, being to the extent of upwards of 20 per cent., was instanced, which, nevertheless, had no effect on the amount of the exports; and, by taking a comparative view of the drawbacks acknowledged by the dealers themselves to be sufficient, and those proposed to be granted by the present bill, showed that the drawbacks which it was in the contemplation of the framers of the bill to allow, were fully sufficient.

It had been stated that the House had always abstained from imposing taxes on the raw material, and particularly iron. It was but lately that iron came to be manufactured to any great extent in this country, but the taxes on foreign iron were multiplied session after session; and, in fact, there were many other taxes which acted as a direct tax on iron, and which never were opposed—namely, the taxes on wood and coal. This tax would not destroy the great iron works, the roads and bridges. The same argument would apply to that which applied to the foreign trade—namely, that the fluctuation in the price never put a stop to these great works, though it differed so much as to be, in the year 1799, 16*l.* a ton; in 1803, 19*l.*; and immediately after that to fall to 14*l.*; and

yet the fluctuation had no effect on the trade. The statements that had been referred to were much exaggerated, and the drawbacks in the bill were sufficient to cover the trade from the effect of the tax. In some instances the drawback proposed to be allowed exceeded that demanded by the manufacturers: in others they were less, but every liberality would be extended, and the drawbacks might be modified or extended, so as to be satisfactory to those concerned.

As to the Excise, no harsh provisions on that head existed in the bill—indeed, such provisions were unnecessary, because a bar of pig-iron could not easily be smuggled.

The tax would bear so small a proportion to the immense capital employed in such concerns, that they could not be materially affected thereby. There was nothing in the state of the countries on the Continent to give rise to the apprehensions entertained with respect to the foreign trade. As to America, it was a country in the infancy of its population, and no wise government would encourage in such a country the employment of its subjects in manufactures to any extent that would enable them to rival this country. The population of that country would be wisely directed to the more productive employment of cultivating their country.

In reply to these arguments, the opposers of the bill stated that the fluctuation in the price of iron, although it was great, could not have had any effect on the foreign markets, as, when iron was dear, we exported very little, on account of our hostility with the northern powers. At that time the demand was so great at home, that, to use a tradesman's expression, the pigs were not allowed to be cold before they were taken away. This demand, of course, raised the price of the commodity, but, some time after, it was lowered considerably, on the suggestion of the manufacturers, who declared that they would be unable to proceed with their business unless they had the raw material considerably cheaper. Much of the flourishing state in which that trade now was, should be attributed to the ingenuity of the persons concerned in it, and nothing could so effectually put a stop to the exertion of this ingenuity as putting the manufacture under the Excise.

Formerly, and till within the last few years, wood or charcoal was the only material by which it was supposed that iron could be made, but the ingenuity of the manufacturers led them to find a substitute in coke. Under the gloomy influence of the Excise, there was every reason to believe that this useful discovery would never have been made. The moment the legislature put on the Excise, they imposed a specific mode of working, from which no appeal could be made, and which must at once put a stop to ingenuity. Insuperable difficulties presented themselves to the execution of the plan laid down. The manufacturers were called on to give notice to the Excise officer of the time at which they were to proceed to work. This was impossible: with all their practice and skill in their business, they could not judge within four hours of the time it might be in their power to open the furnace and proceed to cast, and the Excise officer must be always on the spot, or the manufacturer must be under innumerable penalties. The door must always be open to great frauds. Nothing could be so unjust as to confer on the fraudulent manufacturer the means of evading the duty, and of underselling the fair dealer.

Notwithstanding this powerful opposition, the ministers persisted in carrying the bill into a committee, and the House divided upon the question. Upon the division there appeared 119 in favour of the bill, and 109 against it; leaving to ministers a majority of only ten members; but in a few days after the House had resolved itself into a committee, the ministers were induced to abandon the measure altogether.

CHAP. VI.

GREAT BRITAIN.

In the years 1783 and 1784, Mr. Cort, of Gosport, obtained two patents, one for the puddling, and the other for the rolling of iron— discoveries and improvements of so much importance in the manufacture, that it must be considered the era from which we may date the present extensive and flourishing state of the iron trade of this country; but, preparatory to noticing his inventions, it will be necessary to give an account of the processes hitherto in use for the conversion of iron into malleable or bar-iron.

The ancient and modern methods of extracting iron from its ores differing very materially from each other, it will be necessary to treat of them separately.

Iron*, as it exists in the ore, whether in a state of greater or less oxidation, is capable of being brought to the metallic state, when heated in contact with charcoal, by a much lower temperature than is required for its actual fusion; and the iron being brought to this state, the earthy matter with which it is mixed may be vitrified by the adoption of a proper flux, so as to allow the particles of metallic iron to subside, in consequence of their specific gravity, to the bottom of the mass, although they are only in that soft pasty state which common bar-iron exhibits when it is at a white heat. Now, the blowing machines of the ancient metallurgists being greatly inferior to those which are employed at present, they were obliged to make use only of the richest and most easily reducible ores; and even these they were never able, properly

* Aikin's "Chemical Dictionary."

speaking, to fuse in quantity, so that cast-iron was a modification of this metal wholly unknown to them.

That iron which was termed the best, was prepared in the following manner: — A mass of brickwork was raised five feet in length and breadth, and three and a half feet high, resembling a smith's hearth, except that in the middle of this was sunk a cup-shaped cavity or crucible, one foot in depth, and half a foot wide, in the upper part of which was made a hole opening into a channel through the brickwork. This hole being closed with clay, the crucible was filled with lighted charcoal, heaped up so as to be above the level of the hearth; a blast of air was then admitted through a pipe, let into the wall in the same manner as a smith's forge, and so contrived that the focus of the blast should be just above the centre of the crucible. Charcoal alone was added from time to time, till the hearth became thoroughly hot, and then, at the discretion of the workmen, the ore, in very small pieces, unroasted, but mixed with unslacked quicklime, was laid on alternately with the charcoal. As soon as it had descended low enough to be within the immediate influence of the blast (which in a furnace of this construction would be in a few minutes), the lime and earthy part of the ore became fused into a slag, and, enveloping the iron now in a metallic state, sunk down into the crucible, displacing the charcoal with which it had been at first charged. The matter remaining at rest in the crucible, gave an opportunity to the particles of iron to sink to the bottom, which they did in greater or less proportion according to the fluidity of the slag, and the completely metallic state of the iron. After this process had been going on for the space of from eight to twelve hours, the crucible became filled with melted metal; at this time the hole, which had been at first stopped up with clay, was opened by means of an iron bar, introduced through the channel in the brickwork, and the scoriæ immediately flowed out, leaving the iron behind, covered with hot charcoal. The blast being stopped, the furnace soon got sufficiently cool to allow the workmen to take out the iron, which was found imperfectly concreted together, in a mass nearly of the shape

of a wooden bowl: this being transferred to an anvil, was first carefully hammered with wooden mallets to break off the incrusting scoriæ, and render it sufficiently compact to bear the tilt hammer, to which it was next subjected. Being then divided into five or six pieces, each was separately forged into a bar, and thus the operation was finished. The iron thus obtained was extremely tough and hard, but difficult to work — was in great request for helmets and other articles of defensive armour — and in general for all purposes where toughness and hardness united were particularly required. The rich quality of the ore, and the circumstances in which it was reduced, were probably the chief causes of the excellence of this kind of iron; a peculiarity, however, in the method of forging it, may also have somewhat contributed to this, for while it was under the tilt hammer, an assistant stood by with a ladle of water, with which he sprinkled the bar as often as it was struck by the hammer.

The poorer ores, which are incapable of being smelted in the above method, were first picked, washed, and roasted, then reduced to pieces no larger than hazle nuts, and reduced (no doubt with the addition of lime) in blast furnaces from seven to eight feet high, and shaped like a chimney. In these a considerably greater heat could be produced than in the former, but it does not appear that the metal, when taken out of the furnace, was in the state of cast-iron; certain it is, that it was always allowed to cool there, and was never run into pigs, as is the modern practice.

Some ores that are very rich, and yield a soft iron, have been occasionally wrought in a manner still more simple than either of the preceding. The rich specular ore of the island of Elba in particular, appears formerly to have been worked to a considerable extent in this, which, if not the earliest, is certainly the rudest method that has hitherto been devised. "The ore being broken into small pieces, is heaped upon a bed of charcoal, in a very simple reverberatory furnace. When the whole has been glowing hot for some time, the pieces being now soft, and at a welding heat, are, by the dexterous management of the workmen, brought in close con-

tact with each other by means of an iron bar; they are then lightly hammered, while still in the furnace, and thus the whole mass acquires sufficient compactness to be removed to the anvil without falling to pieces; it is now hammered with a gradually increasing force, the earthy impurities are thrown off together with the scales of black oxide, the lump is divided into pieces of a convenient size, which by repeated heating and hammering are drawn into bars."

These ancient methods have gone into disuse, not because the quality of the iron thus produced was to be objected to, but because the time and fuel consumed were enormous; and the iron that remained in the scoriæ amounted at least to one-half of the original metallic contents of the ore.

The modern methods of reducing the ores of iron are principally two, depending on the nature of the fuel made use of. In England and Scotland it is for the most part coal, but in the rest of Europe charcoal, with the exception of some of the furnaces in France and the Netherlands.

The best Swedish bar-iron, named "Oregrund iron," from the port whence it is shipped for the English market, is entirely prepared from the magnetic ironstone of Dannemora. The forges and foundries where it is manufactured are those of Soderfors, and other places in the province of Roslagia; and the most approved processes that it undergoes for this purpose are the following:—

The ore, in moderately large pieces, such as it comes from the mine, is first roasted. For this purpose, an oblong coffer of masonry, 18 feet long, 15 feet wide, and about 6 feet in depth, open at top, and furnished with a door at one of its smaller extremities, is entirely filled with logs of wood; over this the ore is piled to the height of from five to seven feet, and is covered with a coating of small charcoal, almost a foot and a half in thickness. Fire is then communicated to the bottom of the pile by means of the door just mentioned, and in a short time the combustion spreads through the whole mass: the small quantity of the pyrites that the ore contains is decomposed by the volatilisation of the sulphur; the moisture is also driven off, and the ore, from being very hard and

refractory, becomes pretty easily pulverisable. In the space of twenty-four hours the roasting is completed, and the ore, when sufficiently cool, is transferred to a stamping-mill, where it is pounded dry, and afterwards sifted through a network of iron, which will not admit any piece larger than a hazel nut to pass. It is now ready to be smelted.

The smelting furnace is a strong quadrangular pile of masonry, the internal cavity of which, though simple in form, is not very easily described; it may be considered, however, in general, as representing two irregular truncated cones, joined base to base; of these the lower is scarcely more than one-third of the upper, and is pierced by two openings, through the upper of which the blast of wind from the blowing machine is admitted into the furnace; and from the lower the melted matter, both scoriæ and metal, is discharged from time to time at the pleasure of the workmen.

The furnace is first filled with charcoal alone, and well heated; after which, alternate charges are added, of ore, either alone, or mixed with limestone if it requires any flux, and charcoal; the blast is let on, and the metal in the ore being highly carbonised in its passage through the upper part of the furnace, is readily melted as soon as it arrives in the focus of the blast, whence it subsides in a fluid state to the bottom of the furnace, covered with a melted slag. Part of the clay that closes the lower aperture of the furnace is occasionally removed, to allow the scoriæ to flow out, and at the end of every ninth hour the iron itself is discharged into a bed of sand, where it forms from ten to twelve small pigs. As soon as the iron has flowed out, the aperture is closed again, and thus the furnace is kept in incessant activity during the first six months of the year; the other six months are employed in repairing the furnaces, making charcoal, and collecting the requisite provision of wood and ore.

The next process for the conversion of pig into bar-iron, is refining; for this purpose a furnace is made use of, resembling a smith's hearth, with a sloping cavity, sunk from ten to twelve inches below the level of the blastpipe. This cavity is filled with charcoal and scoriæ; and on the side opposite to the

blastpipe is laid a pig of cast-iron, well covered with hot fuel. The blast is then let in, and the pig of iron being placed in the very focus of the heat, soon begins to melt, and, as it liquifies, runs down into the cavity below : here, being out of the direct influence of the blast, it becomes solid, and is then taken out and replaced in its former position—the cavity being then filled with charcoal; it is thus fused a second time, and after that a third time — the whole of these three processes being usually effected in between three and four hours: as soon as the iron has become solid, it is taken out and very slightly hammered, to free it from the adhering scoriæ; it is then returned to the furnace, and placed in a corner, out of the way of the blast, and well covered with charcoal, where it remains, till, by further gradual cooling, it becomes sufficiently compact to bear the tilt hammer. Here it is well beaten till the scoriæ are forced out, and it is then divided into several pieces, which, by a repetition of heating and hammering, are drawn into bars, and in this state is ready for sale. The proportion of pig-iron obtained from a given quantity of ore is subject to considerable variation, from a difference in the metallic contents of different parcels of ore, and other circumstances; but the amount of bar-iron that a given weight of pig metal is expected to yield is regulated very strictly, the workmen being expected to furnish four parts of the former for five parts of the latter, so that the loss does not exceed 20 per cent.

The method of preparing bar-iron in all the other countries of Europe, where charcoal is the fuel made use of, is, upon the whole, very similar to that just detailed, allowing for a few variations, according to the different species of ore that are employed; but, in Great Britain, the number of charcoal furnaces, towards the end of the last century, were trifling compared with those where coke was used, and the adoption of this kind of fuel led, by necessity, to a method of manufacturing iron quite peculiar to this country, and wholly inapplicable to those establishments that are carried on by means of charcoal.

The first step in the process, after the iron was run from

the furnace, was refining. For this purpose the pigs were smelted in a refinery (the construction of which has been already noticed) by means of charcoal, which was still used in the refinery; and as soon as the metal was in fusion, it was let out into a mould of sand, to separate the scoriæ that rise to its surface, and in this state was called a half-bloom. As soon as it became solid, it was again transferred to the furnace, and treated as before; sometimes even a third fusion was required before the iron showed sufficient malleability to clot into lumps when beaten down, almost at a fusing heat, by an iron bar. When it had acquired this consistency, it was taken out in moderate-sized pieces, which, being placed under the great forge, or shingling hammer, was speedily stamped into cakes, about an inch thick; several piles of these cakes, about a foot high, were then laid on flat circular stones, and placed on the balling or reverberatory furnace, where they were strongly heated. As soon as the whole acquired a pasty state, one of the piles was taken out by a workman, and drawn under the hammer into a short bar, which, being finished, was applied to another of the piles, to which it soon adhered; and, being then withdrawn, the new portion was welded firmly to the first, by means of the hammer, and thus the bar was doubled in length; by repeating the same simple and ingenious operation, the bar was made as long as its weight would conveniently allow. The cracks in the bar were then closed, and its tenacity was improved by heating it afresh in a fire, made of coal, called the chaffery, and again subjecting it to the action of the forge hammer. It was now in the state of common bar-iron, and ought to be entirely free from all earthy particles. After this, according to the use for which it was intended, it was transferred to the slitting mill, where it was laminated, and cut up into bars and rods, of various dimensions, by which its toughness and compactness was much improved, and was then ready for the smith. The above method was called stamping; but, besides this, there was another, called flourishing, which requires a short notice. In this the pigs of cast-iron, when put into the refinery, were kept for about two hours and a half in a pasty state, without

actually melting; and at the end of this period the metal was taken out by shovels, and laid on the open floor, on a plate of cast-iron, where it was beaten with hand hammers, in order to knock off the cinders, and other adhering impurities. It was afterwards placed under the forge hammer and beaten — at first gently, till the whole mass had acquired some tenacity, and then the middle part was drawn into a bar four feet long, terminated at each extremity by a cubical lump of rough iron — in this state it was called an ancony. It was then taken to the chaffery, hammered afresh, and the ends being also drawn down to the same dimensions as the other part, the bar was completed.

A considerable waste of iron was, in these various processes, sustained, amounting to 10 or 12 cwt. for every ton of bars that was finished; but the difference of the price of fuel compensated for this additional loss, and the necessity of the case, from the diminution of wood, and increased demand, had become imperious.

The manufacture of bar-iron remained subject to the stamping process many years, and the quality of the iron so made was strong and generally tough, but the tardy finish of the hammer, and the arrangement of the whole, was not calculated speedily to overcome quantity, and it was considered a respectable establishment that could turn out, in one week, twenty tons of bars fit for the market.

Refineries could not be multiplied without an additional increase of blast, and this in general could not be done without additional steam-engines, and the manufacture had become apparently stationary, when the discoveries of Mr. Cort furnished the iron masters with a new and interesting field for enterprise.

The object of Mr. Cort's processes was to convert into malleable iron, cast or pig-iron, by means of the flame of pit coal, in a common air furnace, and to form the result into bars, by the use of rollers in the place of hammers. The process was managed in the following manner: —

" The pigs of cast-iron produced by the smelting furnace are broken into pieces, and are mixed in such proportions,

according to their degree of carbonisation, that the result of the whole shall be a grey metal. This mixture is then speedily run in a blast furnace, where it remains a sufficient time to allow the greater part of the scoriæ to rise to the surface. The furnace is now tapped, and the metal runs into moulds of sand, by which it is formed into pigs, about half the size of those which are broken into pieces. A common reverberatory furnace, heated by coal, is now charged with about 2½ cwt. of this half-refined grey iron. In a little more than half an hour, the metal will be found to be nearly melted; at this period the flame is turned off, a little water is sprinkled over it, and a workman, by introducing an iron bar, or an instrument shaped like a hoe, through a hole in the side of the furnace, begins to stir the half fluid mass, and divide it into small pieces. In the course of about fifty minutes from the commencement of the process, the iron will have been reduced, by constant stirring, to the consistence of small gravel, and will be considerably cooled. The flame is then turned on again, the workman continuing to stir the metal, and in three minutes' time the whole mass becomes soft and semi-fluid, upon which the flame is again turned off. The hottest part of the iron now begins to heave and swell, and emit a deep-blue lambent flame, which appearance is called fermentation; the heaving motion and accompanying flame soon spread over the whole, and the heat of the metal seems to be rather increased than diminished for the next quarter of an hour; after this period the temperature again falls, the blue flame is less vigorous, and, in a little more than a quarter of an hour, the metal is cooled to a dull red, and the jets of flame are rare and faint. During the whole of the fermentation the stirring is continued, by which the iron is at length brought to the consistency of sand; it also approaches nearer to the malleable state, and, in consequence, adheres less than at first to the tool with which it is stirred. During the next half hour the flame is turned off and on several times, a stronger fermentation takes place; the lambent flame also becomes of a clearer and lighter blue—the metal begins to clot, and becomes much less fusible, and more tenacious than at first—the

fermentation, then, by degrees, subsides—the emission of blue flame nearly ceases—the iron is gathered into lumps, and beaten with a heavy-headed tool. Finally, the tools are withdrawn, the apertures through which they were worked are closed, and the flame is again turned on in full force for six or eight minutes. The pieces being thus brought to a high welding heat, are withdrawn and shingled; after this, they are again heated, and passed through grooved rollers, by which the scoriæ are separated, and the bars thus forcibly compressed acquire a high degree of tenacity."*

Mr. Cort made many experiments in the progress of establishing his inventions; but, so long as the various quantities of pig-iron only were the subject of operation, the results in the puddling furnace, his invention, were uncertain, attended with waste, and unequal in quality.

These obstacles were at length removed by the introduction of the coke refinery. The idea of melting the pig-iron in fineries with coke, occurred to, and was put into operation by, the late Mr. Samuel Homfray, at Penydarran. This succeeding, the puddling and balling furnaces came immediately into action, and both into general use, with the addition of the use of rollers in lieu of hammers.

Neither Mr. Cort nor his family, however, derived any advantage from these most important and valuable discoveries, which have given to this country the command of the markets of the world. In the year 1812, Mr. Coningsby Cort, after the death of his father, presented a petition to the House of

* Mr. Eaton, in his "Survey of the Turkish Empire," states the following circumstance as having occurred to his own knowledge:—An Arabian of Constantinople had discovered the secret of casting iron, which, when it came out of the mould, was as malleable as hammered iron. Some of his fabrication was accidentally shown to M. de Gaffron, the Prussian Chargé d'Affairs, and M. Franzaroli (men of mineralogical science), who were struck with the fact, and immediately instituted an inquiry for its author. This man, whose art in Christendom would have insured him a splendid fortune, had died poor and unknown, and his secret had perished with him. His utensils were found, and several pieces of his casting, all perfectly malleable! M. Franzaroli analysed them, and found that there was no admixture of any other metal. M. de Gaffron has since been made superintendent of the iron manufactory at Spandau, where he in vain attempted to discover the process of the Arabian.

Commons. Mr. Manners Sutton, by command of his Royal Highness the Prince Regent, acquainted the House that his Royal Highness having been informed of the contents of the said petition, recommends it to the consideration of the House.

The petition set forth "that, in the years 1783 and 1784, two respective patents were granted by his present Majesty to the petitioner's late father; the one for a new and improved method of making iron in a reverberatory, or air furnace, heated by common raw pit-coal; and the other for manufacturing the iron, when malleable, into bars, bolts, and a variety of other uses, by passing it in a welding heat through rollers, with grooves accurately formed, instead of working it under forge hammers — a process never before adopted or brought to perfection, and now in general use; and that the petitioner's father expended the whole of his private fortune in bringing the said discoveries to perfection, and in endeavouring to establish the means of availing himself of the benefits of his patents; and that various unforeseen misfortunes, arising from the failure of the funds of the petitioner's father, prevented him reaping the benefit of his discoveries, and in the meantime the period of his patents expired, and the process had come into general use, and the petitioner's father was wholly deprived of the means of participating in the benefits of his discoveries — so valuable to the public, and advantageous to all those engaged in the trade; and that the patent method is not only generally adopted throughout Great Britain, but, from its immense and progressive increase of late years, has been the means of rendering the nation, in this most important branch of commerce, independent of all foreign countries, whereby very large sums, formerly paid to Russia and Sweden at their ports of exportation, and which, from the late vast augmentation of demand in this article of trade, would be greatly increased, are saved; and iron is now made in this country fit for the use of his Majesty's navy, equal in body, strength, and toughness, to the first sort of Swedish ore-ground iron, and at a much cheaper rate than it could be obtained by importa-

tion; and that it is now computed, and admitted by the trade, that there is about 250,000 tons of wrought-iron manufactured according to the principles of the patent method of the petitioner's father: and that about 150,000 tons of iron, part of the above quantity, are rolled into bars, upon the exact and precise principle laid down in the specification of the patents granted to the petitioner's father, without any practical deviation whatever."

This petition was referred to a committee, and was opposed by some of the iron masters, who produced evidence to prove that the iron manufactured according to Mr. Cort's process of puddling, was of very inferior quality. The committee reported upon the petition, and an estimate of the sum wanted for carrying into effect the resolutions of the committee, amounting to 250*l.*, was some time afterwards laid before the House, and here the matter rested.

To give some idea of the importance of Mr. Cort's invention of the rollers, it may be as well here to mention that, previous to their introduction, the smallest size drawn under the hammer was three-quarters square; all below that size were cut in the splitting-mill,* and it required the hammer to

* The most extraordinary and the best attested instance of enthusiasm existing in conjunction with perseverance, is related of the founder of the Foley family. This man, who was a fiddler, living near Stourbridge, was often witness of the immense labour and loss of time caused by dividing the rods of iron, necessary in the process of making nails. The discovery of the process called splitting, in works called splitting-mills, was first made in Sweden, and the consequences of this advance in art were most disastrous to the manufacturers of iron about Stourbridge. Foley, the fiddler, was shortly missed from his accustomed rounds, and was not again seen for many years. He had mentally resolved to ascertain by what means the process of splitting of bars of iron was accomplished; and, without communicating his intention to a single human being, he proceeded to Hull, and thence, without funds, worked his passage to the Swedish iron port. Arrived in Sweden, he begged and fiddled his way to the iron foundries, where, after a long time, he became a universal favourite with the workmen; and, from the apparent entire absence of intelligence, or anything like ultimate object, he was received into the works, to every part of which he had access. He took the advantage thus offered, and having stored his memory with observations and all the combinations, he disappeared from amongst his kind friends as he had appeared—no one knew whence or whither. On his return to England he communicated his voyage and its results to Mr. Knight and another person in the neighbourhood, with whom he was associated, and by whom the necessary buildings were erected and machinery pro-

be kept constantly at work to draw 20 cwt. of average sizes in twelve hours, while, with the rollers they can manufacture, in the same time, with one pair of rollers, about 15 tons, which, in a work in full operation, are kept constantly employed, day and night, during six days of the week. Of the small sizes they roll about five tons in the twelve hours.

The iron trade continued rapidly to increase, and as the great addition was principally in Wales, where the manufacture, as compared with Shropshire and Staffordshire, may be considered as of modern growth, we will shortly refer to the origin of the trade in that part of the country.

About the year 1755, Merthyr Tydvil, then an inconsiderable village, attracted the notice of Mr. Anthony Bacon, on account of the iron and coal mines with which this tract of country abounds. For the low rent of 200*l.* per annum, he obtained a lease, of ninety-nine years, of a district, eight miles in length by five in breadth, upon which he erected iron and coal works. At the beginning of the American war, Mr. Bacon contracted with government for casting cannon. Proper furnaces were erected for this purpose, and a good turnpike-road was made down to the port of Cardiff, along an extent of twenty-six miles. At Cardiff likewise a wharf was formed, still called the Cannon Wharf, whence the cannon were shipped off to Plymouth, Portsmouth, and wherever the service required. The cannon were carried in waggons down to Cardiff, at a great expense of carriages, horses, and roads.

vided. When at length everything was prepared, it was found that the machinery would not act; at all events, it did not answer the sole end of its erection—it would not split the bar of iron. Foley disappeared again, and it was concluded that shame and mortification at his failure had driven him away for ever. Not so: again, though somewhat more speedily, he found his way to the Swedish iron works, where he was received most joyfully, and, to make sure of their fiddler, he was lodged in the splitting-mill itself. Here was the very end and aim of his life attained beyond his utmost hope. He examined the works, and very soon discovered the cause of his failure. He now made drawings, or rude tracings; and having abided an ample time to verify his observations, and to impress them clearly and vividly on his mind, he made his way to the port, and once more returned to England. This time he was completely successful, and, by the results of his experience, enriched himself and greatly benefited his countrymen. This I hold to be the most extraordinary instance of credible devotion in modern times.—*Letters, Conversations, and Recollections of S. T. Coleridge, Esq.*

This contract is supposed to have been very lucrative to Mr. Bacon, but he was obliged to relinquish it about the close of the American war, or rather to transfer it to the Carron Company, in Scotland, where most of the cannon are still cast. He made this disposal that he might be enabled to hold a seat in Parliament, to which he had been elected. Soon afterwards, about the year 1783, having accumulated a splendid fortune, he disposed of his mineral kingdom, by leases, to different parties, and in lots:—the Cyfarthfa works, the largest portion, to Mr. Crawshay; Penydarran, to Mr. Homfray; Dowlais, to Messrs. Lewis and Tate; and a fourth part (the Plymouth works) to Mr. Hill.

Mr. Malkin, in his "Antiquities of South Wales," published in the year 1803, says—"Mr. Crawshay's Iron Works, of Cyfarthfa, are now by far the largest in this kingdom. He employs constantly upwards of 2000 men. He makes, upon an average, between sixty and seventy tons of bar-iron every week, and has lately erected two new additional furnaces, which will soon begin to work, when he will be able to make, one week with another, 100 tons of bar-iron. Mr. Homfray makes weekly, on a moderate average, fifty tons of bar-iron and upwards, and is now extending Penydarran and its buildings, which will soon be completed; he will then make at least eighty tons per week. Dowlais Iron Works, belonging to Messrs. Lewis and Tate, are on as large a scale as those of Penydarran, and about to be augmented in an equal proportion. Those of Mr. Hill make thirty tons of iron weekly and upwards; additional buildings are now erecting, which, when finished, will make at least forty tons per week. At present more than 200 tons of iron are sent down the canal weekly to the port of Cardiff, whence it is shipped off to Bristol, London, Plymouth, Portsmouth, and other places, and a considerable quantity to America. "It is supposed that, in the course of a year or two, they will be able to send out 300 tons weekly. The number of smelting furnaces at Merthyr Tydvil is about sixteen. Six of these belong to Cyfarthfa works, the rest to the other gentlemen who have been named. Around each of these furnaces are erected

forges and rolling-mills, for converting pig into plate and bar-iron."

Great as this increase may appear, as compared with the whole manufacture of Great Britain a few years previously, yet how small as compared with the increase which shortly took place, as will appear by the following account of the iron sent down the Glamorganshire Canal, from the 1st day of January, 1817, to the 1st day of January, 1831. These returns consist almost entirely of manufactured iron, but the proportions have not been ascertained:—

	1817.	1818.	1819.	1820.	1821.	1822.	1823.
Cyfarthfa and Hirwain -	14,191	15,706	16,646	19,010	18,070	17,137	19,452
Dowlais - - - -	9,936	9,694	10,796	11,115	12,571	14,557	14,025
Penydarran - -	8,275	8,834	7,549	8,690	10,018	9,924	10,240
Plymouth - - -	7,095	7,377	7,633	7,941	9,943	8,833	10,920
Aberdare - - -	- -	- -	- -	2,626	1,863	2,023	2,659
Total tons -	39,497	41,611	42,624	49,382	52,465	52,474	57,296

	1824.	1825.	1826.	1827.	1828.	1829.	1830.
Cyfarthfa and Hirwain -	20,399	23,063	20,206	29,312	30,011	24,768	19,892
Dowlais - - - -	12,594	15,851	16,601	20,726	23,575	23,352	27,647
Penydarran - -	10,358	10,611	8,691	10,369	10,223	10,085	11,744
Plymouth - - -	9,499	11,269	7,836	12,907	12,976	13,534	12,177
Aberdare - - -	4,234	6,354	6,686	8,472	9,864	8,644	6,765
Brown and Co.	969	1,178	57	1,059	720	767	621
R. Blakemore -	- -	- -	- -	2,101	2,056	2,001	2,702
Gadly's - - - -	- -	- -	- -	- -	414	559	- -
Bute - - - - -	- -	- -	- -	- -	- -	166	- -
Total tons -	58,053	68,326	60,077	84,946	89,839	83,876	81,548

The extraordinary increase of the manufacture in the Monmouthshire district is, from its extent, more remarkable than that which has just been described. Mr. Coxe, in his "Historical Tour in Monmouthshire," published in the year 1801, speaking of the abundance of ironstone, coal, and limestone in that county, says—

"The mountainous district which contains these mineral treasures is held by the Earl of Abergavenny, under a lease from the Crown. It was formerly let to the family of Hanbury, of Pont-y-pool*, for less than 100*l.* a-year; and as the value of the mines was not sufficiently appreciated, no works were constructed, but the masses of ore found near the surface were conveyed to the forges of Pont-y-pool. Soon after the expiration of the term the district was granted, by another lease, to Hill and Co., who began the Blaenavon works in 1788. When it was proposed to erect the furnaces, the principal difficulty was supposed to be the want of proper stone for the hearths; it was decided, therefore, on having it from the neighbourhood of Stourbridge. While the first hearth-stone was on its way to Blaenavon, stone suitable for the purpose was discovered near the intended works, and that from Stourbridge was cast by the road-side.

"On considering the rise and rapid progress of the iron manufactories in this district, as well as in the neighbouring mountains of Monmouthshire and Glamorganshire, it is a matter of wonder that these mineral treasures should have been so long neglected. This wonder will increase when it is known that iron was manufactured in this country at a period beyond the reach of tradition or history. Large heaps of slag, or cinder, have been repeatedly discovered, some of which are evidently the product of bloomeries—the most ancient method of fusing iron; in other places are traced the sites of furnaces long disused, of which no account of their foundation can be collected. The appearance of these iron cinders, and the vestiges of ancient furnaces, indicate that many parts of this mountainous district, now wholly bare, were formerly covered with large tracts of wood. This conjecture is corroborated by numerous names, alluding to woods and forests, in places which have never been known to produce trees; and is still further ascertained by the discovery of trunks and branches,

* Capel Hanbury, descended from an ancient house in Worcestershire, is the earliest proprietor on record of the iron works at Pont-y-pool. The earliest conveyance deeds are dated 1565, and a regular account of the sale of iron commences in 1588.—*Williams's History of Monmouthshire.*

with their leaves, under the boggy soil, in the vicinity of Blaenavon and on the neighbouring hills.

"The lands being cleared, and the forests neglected, their destruction was hastened by numerous herds of goats, maintained in these mountainous regions; the want of fuel occasioned the gradual decline of the bloomeries and furnaces, and for a considerable period little or no iron was manufactured.

"About forty years ago the iron works suddenly revived, from the beneficial discovery of making iron with pit-coal instead of charcoal, which was soon afterwards followed by the improvement of manufacturing even bar-iron by means of pit-coal: hence, a district which contained such extensive mines of ore and coal, prodigious quantities of limestone, and numerous streams of water, could not fail of becoming the seat of many flourishing establishments. Besides these local advantages, the progress of the manufactories has been powerfully aided by the application of mechanics, particularly by the use of the steam-engine, and the great improvement of water machines; but in no instance have they derived more advantage than from the adoption of rollers instead of forge hammers, now used for the formation of bar-iron, with a degree of dispatch, as well as exactness, before unknown. From this concurrence of circumstances, the success has been no less rapid than extraordinary. Fifteen years ago the weekly quantity of pig-iron made in this part of Monmouthshire, and in the contiguous district of Glamorganshire, did not exceed sixty tons; at present it scarcely falls short of 600 tons; at that period no bar-iron was manufactured, but now the quantity amounts weekly to more than 300 tons. The works are still rapidly increasing in extent and importance, and appear likely to surpass the other iron manufactories throughout the kingdom."

This prediction has been fulfilled, as will appear by the following statement, showing the quantities of iron conveyed down the Monmouthshire Canal, from the year 1802 to the 1st January, 1831:—

IRON CARRIED ON THE MONMOUTHSHIRE CANAL, AND NAMES OF THE WORKS.

Years.	Blaenavon.	Garndyrris.	Beaufort.	Clydach.	Ebbw Vale.	Varteg.	Tredegar.	Nant-y-glo.	Coal-brooke Vale.	Blaina.	Pentwyn.	Abersy-chan.	Bute.	Sundry persons.	Total tons.
1802	1,091	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1,091
1803	2,079	- -	1,612	447	1,655	81	- -	- -	- -	- -	- -	- -	- -	2,805	8,679
1804	8,490	- -	2,950	1,266	2,890	771	- -	- -	- -	- -	- -	- -	- -	4,107	20,474
1805	7,262	- -	4,605	1,455	1,012	1,094	956	- -	- -	- -	- -	- -	- -	6,047	22,431
1806	6,594	- -	3,989	1,599	3,252	2,482	3,124	- -	- -	- -	- -	- -	- -	2,954	23,994
1807	6,042	- -	3,947	1,196	2,209	2,745	4,138	- -	- -	- -	- -	- -	- -	2,742	23,019
1808	7,163	- -	4,004	963	1,553	2,379	5,529	- -	- -	- -	- -	- -	- -	2,960	24,551
1809	9,848	- -	3,566	1,136	786	2,053	9,105	- -	- -	- -	- -	- -	- -	3,247	29,741
1810	12,254	- -	3,948	1,372	2,758	1,676	7,696	- -	- -	- -	- -	- -	- -	4,366	34,070
1811	12,377	- -	3,910	872	2,633	583	6,643	77	- -	- -	- -	- -	- -	3,364	30,459
1812	14,579	- -	3,995	1,774	4,648	120	7,862	1,168	- -	- -	- -	- -	- -	5,874	40,020
1813	13,562	- -	3,204	2,174	5,939	141	7,597	1,855	- -	- -	- -	- -	- -	7,350	41,822
1814	12,438	- -	3,146	1,472	4,752	- -	9,131	2,292	- -	- -	- -	- -	- -	8,607	41,838
1815	14,002	- -	3,767	2,999	4,953	- -	9,225	4,684	- -	- -	- -	- -	- -	6,577	46,207
1816	11,773	- -	3,164	2,658	2,949	- -	7,499	6,160	- -	- -	- -	- -	- -	4,240	38,443
1817	11,080	2,247	2,104	3,162	3,127	127	10,350	7,242	- -	- -	- -	- -	- -	3,968	43,407
1818	8,771	5,097	2,100	3,947	2,476	- -	8,258	7,325	- -	- -	- -	- -	- -	4,038	42,012
1819	6,776	4,427	2,124	3,788	1,907	225	7,140	7,934	- -	- -	- -	- -	- -	3,388	37,709
1820	9,423	2,798	3,132	3,397	3,605	360	8,211	8,826	- -	- -	- -	- -	- -	5,710	45,462
1821	8,973	2,838	2,962	3,876	6,041	3,757	9,923	10,460	1,880	- -	- -	- -	- -	6,580	57,290
1822	5,831	3,476	3,786	4,225	5,960	4,453	8,102	10,906	919	- -	- -	- -	- -	4,774	52,432
1823	10,745	4,370	4,269	3,651	8,613	5,031	9,903	12,723	1,582	- -	- -	- -	- -	5,677	66,564
1824	11,265	4,517	5,347	3,617	10,101	5,290	11,444	15,134	1,541	212	- -	- -	- -	7,852	76,320
1825	9,043	4,218	7,091	3,748	10,325	4,512	11,012	16,536	3,596	1,588	83	- -	- -	7,048	78,800
1826	8,059	2,145	6,028	3,660	10,297	5,128	10,962	11,512	2,874	2,098	738	- -	- -	6,282	69,783
1827	8,255	2,446	5,914	4,107	14,403	7,427	13,837	18,059	3,016	2,991	4,140	113	- -	6,910	91,618
1828	9,766	2,645	5,701	5,183	15,479	8,131	14,341	19,032	3,756	3,507	4,147	6,478	6,320	6,432	110,918
1829	10,124	2,242	6,896	6,967	16,959	9,232	13,349	17,433	1,902	4,863	4,698	7,760	9,909	4,197	116,531
1830	9,397	3,654	5,065	6,771	18,133	8,988	12,303	17,115	1,905	4,195	5,425	7,615	5,728	6,353	112,647

In the early part of the year 1825, Mr. Herries, then Chancellor of the Exchequer, on bringing forward the budget, proposed a considerable reduction of the duties on foreign iron — these duties had been gradually rising for some years: —

From 1782 to 1795	the duty on foreign bars was		£2	16	2	per ton,
1796	„	„	3	1	9	„
1797	„	„	3	4	7	„
From 1798 to 1802	„	„	3	15	5	„
1803	„	„	4	4	$4\frac{1}{2}$	„
1804	„	„	4	17	1	„
1805	„	„	5	1	0	„
From 1806 to 1808	„	„	5	7	$5\frac{3}{4}$	„
1809 to 1812	„	„	5	9	10	„
1813 to 1818	„	„	6	9	10	„
1819 to 1825	„	„	6	10	0	„
	if imported in British ships, and		7	18	6	„

if imported in foreign ships.

The Chancellor of the Exchequer, after showing a prospective surplus revenue, stated the objects he had in view in his intended application of it; the principal of which was, the extension of commerce, by increasing the facility of consumption of foreign produce in this country. "He considered that there were many articles upon which the very high, and, in many cases, the prohibitory duties ought to be withdrawn, but there was one upon which he could not help saying a few words, he meant foreign iron. He hoped that those engaged in the home manufacture would not object to its introduction. Indeed, if they consulted their own interests, they must be aware that such a measure would, in the result, be to their advantage. The price of iron had lately risen to an enormous height, not from any new speculation in that article, not from any belief that the country was to be covered with iron railroads, and that all the iron which could be dug out of the bowels of the earth would be required to supply the demand, but from a general increase of trade, produced by the increased and increasing comforts and prosperity of the people in this and other nations. The fact was, the supply of iron in this country was not at all in proportion to the demand. He knew that there were at the present

moment foreign orders in Sheffield and Birmingham which could not be executed, because the manufacturers there could not supply the article at the price which the foreign customers could afford to pay. The consequence was, that several such orders had been withdrawn and sent to other countries, where, though they could not be executed in the same good style, yet, as being much cheaper, they were preferred by those who could not afford the higher price. It was not sound policy in this country to continue restrictions which had the effect of thus crippling a very important branch of her manufacture. He was happy to say, that very many of the iron masters whose transactions were most extensive, did not object to the measure which was about to be proposed, of reducing the duty on foreign iron. They were above the narrow and selfish policy of opposing the introduction of a foreign article, which might seem for a moment to come in contact with their own trade, but which in reality would be a benefit to them, by giving an increased stimulus to other branches of our domestic manufacture. He thought the interests of the community would be best consulted by reducing the duty from 6*l.* 10*s.* to 1*l.* 10*s.* As the high duty had acted as a kind of prohibitory duty on the importation of foreign iron, the immediate loss to the revenue would not be any thing worth naming; but he was certain that, before the end of the year, it would be found that the low duties would have made a considerable addition to the income from customs. It was to be observed, however, with respect to this particular duty, that the change from the high to the low duty should be effected with caution, and should not be made with respect to all countries at once; and this was his reason, one of the objects which he had in view in removing those high prohibitory duties, was to set to other nations an example of what would, in the end, be for their, as well as our interests. Some countries had already shown a disposition to avail themselves of it; but it could not be expected that all countries would at once enter into our feelings on that subject. We ourselves, it should be recollected, were a long time before we got rid of the trammels which fettered our trade in these points. There

were, however, some states who were willing to adopt our regulations, and to open their ports to articles of our produce. To these the remission of the heavy duties would, for the present, be confined, and they would find from us a full compensation for the advantages they were thus disposed to give. But to those nations who were still so far behind in a practical application of commercial knowledge, to those who continued to heap restriction upon restriction, it was not to be expected that we should grant advantages which they withheld from us. Still he had every reason to hope that the exclusion of those states from the benefits of a more enlightened commercial policy would be but temporary, and that, before long, all nations would see the propriety of imitating an example which must, in the end, be for their advantage. He had no doubt that our example would, in the end, produce general imitation; provided that we did not alter our policy, that we did not undo in one year the good which we had effected in another.

This proposed reduction of duty met with opposition from some of the iron masters, and a petition was presented to the House against it. This petition, however, did not receive much support; and the only iron master who was a member of the House, Mr. Alderman Thompson, expressed himself as favourable to the measure; and although he did not anticipate so great a reduction, yet he, who was largely interested in the trade, was not afraid of the foreign competition. He was an advocate of liberal commercial principles.

Mr. Huskisson, President of the Board of Trade, proposed the resolutions for an alteration in the duties, of which the following relate to iron and steel: —

	Present duty.	Proposed duty.
IRON, viz.—In bars or unwrought, the produce of any British possession, and imported from thence, per ton - - - - - - - - -	£ *s.* *d.* 1 2 2	£ *s.* *d.* 0 2 6
In bars, or unwrought, the produce of any other country, per ton - - - - - - -	6 10 0	1 10 0
Slit or hammered into rods, and iron drawn or hammered, less than three quarters of an inch square, per cwt. - - - - - - -	1 0 0	0 5 0

	Present duty.			Proposed duty.		
	£	s.	d.	£	s.	d.
IRON, viz.—Cast, for every 100*l.* of the value - -	20	0	0	10	0	0
Old broken, and old cast iron, per ton - -	0	17	6	0	12	0
Ore, per ton - - - - - - - - -	0	8	9	0	5	0
Pig, per ton - - - - - - - - -	0	17	6	0	10	0
Pig, the produce of, and imported from any British possession in America, per ton - - - -	0	8	0	0	1	3
Wrought, not otherwise enumerated or described, for every 100*l.* of the value - - - - -	50	0	0	20	0	0
Wire, not otherwise enumerated or described, per cwt. - - - - - - - - - -	5	18	9	1	0	0
Hoops, per cwt. - - - - - - - -	1	3	9	1	3	9
STEEL—Or any manufacture of steel, not otherwise enumerated or described, for every 100*l.* of the value	50	0	0	20	0	0

without discrimination of ships.

These resolutions were agreed to and subsequently embodied in The General Customs Act of the 6th Geo. IV. c. 3., which took effect on the 5th January, 1826.

At the request of Government, a comparative statement was prepared by Mr. F. Finch, of the quantity of pig-iron made in Great Britain in 1823 and 1830. This statement shows the number of furnaces at these dates, and the number erected in each intermediate year. Mr. Poulett Thomson, in his speech on Navigation Laws and Commercial Policy, May, 1832, referred to this great increase in the manufacture of iron.

COMPARATIVE STATEMENT.

SHROPSHIRE.

Furnaces.	1823.		Erected in the years							1830.	
	Total No.	Quantity made.	1824	1825	1826	1827	1828	1829	1830	Total No.	Quantity made.
		Tons.									Tons.
Broseley - - -	2	- -	-	-	-	-	-	-	-	2	270
Barnett Leasow	2	2,755	-	-	-	-	-	-	-	2	1,316
Benthall - - -	1	- -	-	-	-	-	-	-	-	1	- -
Calcutts - - -	2	1,833	-	-	-	-	-	-	-	2	- -
CoalbrookeDale	2	- -	-	-	-	-	-	-	-	2	- -
Dawley Castle -	2	4,925	-	-	-	-	-	-	-	2	4,312
Donnington -	3	8,074	-	-	-	-	2	-	-	5	15,110
Horsehay - -	3	4,854	-	-	-	-	-	-	-	3	6,833
Hadley - - -	2	2,080	-	-	-	-	-	-	-	2	—
Kitley - - -	3	4,984	-	-	-	-	-	-	-	3	5,763
Lightmoor - -	3	6,052	-	-	-	-	-	-	-	3	6,194
Madeley Wood	3	2,475	-	-	-	-	-	-	-	3	3,471
Old Park - -	4	6,900	-	-	-	-	-	-	-	4	15,300
Snedshill - -	2	2,786	-	-	-	-	-	-	-	2	317
Wombridge -	2	5,084	1	-	-	-	-	-	-	3	7,134
Wrockwardine -	2	5,121	-	-	-	-	-	-	-	2	- -
Stirchley - -	-	- -	-	-	-	4	-	-	-	*4	- -
Lawley - - -	-	- -	1	-	-	-	-	-	-	1	3,073
Langley - - -	-	- -	1	-	1	-	-	-	-	2	4,325
Total -	38	57,923	3	—	1	4	2	—	—	48	73,418

The two at Donnington built in lieu of the two at Wrockwardine, which are blown out. Erected in 1832—Madeley, 1.—The increase in the quantity made in the year 1830 upon the quantity made in the year 1823, is 26 per cent.

* The quantity made in 1830 is included in Old Park return.

YORKSHIRE.

Furnaces.	1823. Total No.	Quantity. Tons	1830. Total No.	Quantity. Tons.
Bowling - - -	3	5,366	3	5,117
Brierley - - -	1	2,450	2*	4,590
Chapel Town -	1	1,400	1	1,631
Elsicar - - -	3	1,400	3	1,460
Field Head † - -	—	—	—	—
Holmes - - -	3	2,000	3	1,000
Low Moor - -	4	6,200	4	—
Shelf - - - -	3	—	3	7,480
Milton - - - -	2	2,187	2	1,715
Merfield † - - -	—	—	—	—
Swallow Wood † -	—	—	—	—
Sheffield Park -	2	2,018	2	2,081
Thorncliffe - -	3	2,909	3	2,188
Worsborough -	1	1,381	1	1,664 ‡
Total -	26	27,311	27	28,926

The increase of the quantity made in the year 1830, upon the quantity made in the year 1823, is 5 per cent.

* Erected in 1824—Brierley, 1.
† These furnaces have not been worked for several years.
‡ This quantity is estimated.

STAFFORDSHIRE.

Furnaces.	1823.		Erected in the years							1830.	
	Total No.	Quantity made.	1824	1825	1826	1827	1828	1829	1830	Total No.	Quantity made.
		Tons.									Tons.
Bradley - - -	2	4,195	-	-	-	-	-	-	-	2	4,194
Ditto Lower -	1	1,920	-	-	-	-	-	-	-	1	2.113
Birch Hills - -	2	- -	-	-	-	-	-	-	-	2	- -
Barber's Field -	-	- -	-	-	1	-	1	-	-	2	5,720
Bilston - - -	4	7,696	-	-	-	-	-	-	-	4	4,680
Bilston Brook -	2	4,345	-	-	-	-	-	-	-	2	3,771
Broadwaters -	2	- -	-	-	-	-	-	-	-	2	6,368
Brettell Lane -	-	- -	-	2	-	-	-	-	-	2	2,949
Brierley Hill -	2	4,348	-	-	-	-	-	-	-	2	- -
Brierley - - -	1	- -	-	-	-	-	-	-	-	1	- -
Blower's Green	2	5,348	-	-	-	-	-	-	-	2	5,257
Buffery - - -	3	6,551	-	-	-	-	-	-	-	3	5,246
Buffery, Old -	1	2,646	-	-	-	-	-	-	-	1	2,158
Cotham - - -	2	- -	-	-	-	-	-	-	-	2	- -
Coseley - - -	2	5,200	-	-	1	-	-	-	-	3	10,140
Capon Field -	2	- -	-	-	-	-	-	-	-	2	- -
Chillington - -	-	- -	-	-	-	-	-	2	-	2	6,240
Corbyn's Hall -	-	- -	-	3	-	-	-	1	-	4	7,350
Dudley Port -	1	2,340	-	-	-	-	-	-	-	1	2,340
Ditto - -	-	- -	2	-	-	-	-	-	-	2	4,060
Deepfield - -	2	- -	-	-	-	-	-	-	-	2	- -
Deepdale - -	1	2,084	-	-	-	-	-	-	-	1	1,634
Dudley Wood -	4	10,467	-	-	-	-	-	-	-	4	8,664
Eagle - - -	2	4,900	-	-	-	-	-	-	-	2	6,656
Fiery Holes -	1	- -	-	-	-	-	-	-	-	1	1,634
Glebe - - -	1	- -	-	-	-	-	-	-	-	1	- -
Gospel Oak- -	2	5,312	-	-	-	-	2	-	-	4	6,840
Gold's Green -	2	4,888	-	1	-	-	-	-	-	3	9,412
Graveyard - -	1	- -	-	-	-	-	-	-	-	1	- -
Gorwall Wood-	1	1,671	-	-	-	-	-	-	-	1	- -
Horseley - -	2	4,308	-	-	-	-	-	-	-	2	4,680
Hall Fields - -	1	2,454	-	-	-	-	-	-	-	1	2,454
High Fields -	2	- -	-	-	-	-	-	-	-	2	- -
Lea Brook - -	1	- -	-	-	-	-	-	-	-	1	- -
Leys - - - -	-	- -	-	-	-	-	2	-	-	2	4,160
Level - - -	4	6,464	-	-	-	-	-	-	-	4	- -
Ditto, Old - -	1	2,072	-	-	-	-	-	-	-	1	1,028
Mill Fields - -	4	6,768	-	-	-	-	-	-	-	4	8,112
Moor Croft - -	2	3,700	-	-	-	-	-	-	-	2	4,791
Netherton - -	2	1,406	-	-	-	-	-	-	-	2	5,033
Oldbury - - -	2	2,600	-	-	-	-	-	-	-	2	5,720
Old Park - -	1	2,600	-	-	-	-	1	-	-	2	5,280
Priestfield - -	3	3,664	-	-	-	-	-	-	-	3	4,897
Parkfield - -	-	- -	-	-	2	1	1	-	-	4	9,500
Parkhead - -	1	2,289	-	-	-	-	-	-	-	1	2,468
Rough Hills -	2	- -	-	-	-	-	-	-	-	2	- -
Russell's Hall -	-	- -	-	-	-	2	-	-	-	2	2,080
Stow Heath -	-	- -	-	2	1	-	-	-	-	3	5,408
Toll End - -	3	5,075	-	-	-	-	-	-	-	3	6,112
Tipton Company	3	5,640	-	-	-	-	-	-	-	3	3,515
Tipton - - -	1	2,040	-	-	-	-	-	-	-	1	2,040
Union - - -	-	- -	-	-	-	-	2	-	-	2	4,650
Wednesbury Oak	2	6,240	1	-	-	-	-	-	-	3	7,684
Willingsworth -	-	- -	-	-	-	2	1	-	-	3	5,704
Wolverhampton	-	- -	-	1	-	1	-	-	-	2	3,200
Wallbrook - -	1	2,359	-	1	-	-	-	-	-	2	2,886
Windmill End -	-	- -	-	2	-	-	-	-	-	2	3,776
Total -	84	133,590	3	12	5	6	10	3		123	212,604

The increase of the quantity made in 1830 upon that in 1823, is 58 per cent.
Erected in the year 1831—Leys, 1; Shutend, 2.——1832—Bentley, 2.

SOUTH WALES.

Furnaces.	1823. Total No.	1823. Quantity made.	Erected in the years 1824	1825	1826	1827	1828	1829	1830	1830. Total No.	1830. Quantity made.
		Tons.									Tons.
Abersychan -	-	- -	-	-	6	-	-	-	-	6	10,640
Aberdare - } Abernant - }	3 3	5,676	-	-	-	-	-	-	-	6	12,571
Blaenafon -	5	16,882	-	-	-	-	-	-	-	5	13,843
Beaufort - -	3	5,243	1	-	-	-	-	-	-	4	7,276
Blaina - -	-	- -	3	-	-	-	-	-	-	3	4,905
CoalbrookeVale	1	2,704	1	-	-	-	-	-	-	2	2,780
Cefw Crubur -	-	- -	1	-	-	-	-	-	-	1	- -
Cyfarthfa- -	8	24,200	1	-	-	-	-	-	-	9	29,000
Clydach - -	2	5,200	-	-	1	-	-	-	-	3	10,190
Dowlais - -	8	22,287	-	3	-	-	1	-	-	12	32,611
Gadlys - -	-	- -	-	-	-	-	1	-	-	1	- -
Hirwen - -	2	4,160	2	-	-	-		-	-	4	9,360
Maesteg - -	-	- -	-	-	-	-	1	-	-	1	2,430
Nant-y-glo -	5	17,750	-	-	1	1	-	-	-	7	23,883
Pentwyn - -	-	- -	-	3	-	-	-	-	-	3	5,391
Pontrhydy Ven	-	- -	-	-	2	-	-	-	-	2	- -
Pentycch - -	1	1,235	-	-	-	-	-	-	-	1	2,412
Plymouth- -	3	6,387	-	1	-	1	-	-	-	5	18,582
Penydarran -	5	15,547	-	-	-	-	-	-	-	5	17,015
Romney & Bute	3	5,500	-	-	3	-	-	-	-	6	7,608
Race - -	3	3,173	-	-	-	-	-	-	-	3	2,421
Ryddry - -	-	- -	-	-	-	-	1	-	-	1	220
Sirhowey and } Ebbw Vale }	6	20,425	-	-	-	-	-	-	-	6	26,020
Tredegar - -	5	16,385	-	-	-	-	-	-	-	5	18,514
Varteg Hill -	2	6,513	1	-	1	-	-	-	1	5	13,536
Vig. & Smith's } Cwm Avon }	1	1,560	-	-	-	-	-	-	-	1	1,950
Yniscedwyn -	1	1,498	-	-	-	-	-	-	1	2	2,111
Neath Abbey -	2	- -	-	-	-	-	-	-	-	2	2,374
Pembray - -	-	- -	2	-	-	-	-	-	-	2	- -
Total - -	72	182,325	12	7	14	2	4	-	2	113	277,643

The increase of the quantity made in the year 1830 upon the quantity made in the year 1823, is 52 per cent.

Erected in the year 1831—Sirhowey, 1; Maesteg, 1.

DERBYSHIRE.

	1823. Total No.	1823. Quantity. Tons.	1830. Total No.	1830. Quantity. Tons.
Alfreton - -	2	2,690	2	2,950
Brampton - -	2	1,807	2	1,245
Butterley - -	3	2,639	3	3,981
Calow - - -	1	- -	1	123
Codnor Park -	2	2,096	3*	2,455
Duckmanton -	1	1,091	1	1,446
Grassmore† -	—	——	—	——
Morley Park -	1	544	2*	1,428
Renishaw - -	2	2,120	2	2,810
Staveley - - -	1	1,051	2*	1,561
Total -	15	14,038	18	17,999

The increase of the quantity made in the year 1830 upon the quantity made in the year 1823, is 28 per cent.

* Erected in the year 1825—Morley Park, 1; Staveley, 1. ——1828—Codnor Park, 1.
† Has not been in blast for many years.

NORTHUMBERLAND AND DURHAM.

Furnaces.	1823. Total No.	1823. Quantity. Tons.	1833. Total No.	1833. Quantity. Tons.
Birtley	-	-	2*	3,080
Lemmington	2	2,379	2	2,247
Total	2	2,379	4	5,327

The increase of the quantity made in the year 1830 upon the quantity made in the year 1823, is 123 per cent.

* Erected in the year 1829—Birtley, 2.

BLAST FURNACES IN SCOTLAND.

Names of Works.	1823. Total No.	1823. Quantity made.	Erected in the years 1824	1825	1826	1827	1828	1829	1830	1830. Total No.	1830. Quantity made.
		Tons.									Tons.
Clyde	3	2,500	-	-	-	-	1	-	-	4	8,000
Calder	3	4,000	1	-	-	-	-	-	-	4	9,000
Monkland	-	- -	-	-	1	-	-	1	-	2	2,000
Muirkirk	3	3,500	-	-	-	-	-	-	-	3	4,000
Gartsherry	-	- -	-	-	-	-	-	1	-	1	- -
Shotts	1	2,000	-	-	-	-	-	-	-	1	2,000
Carron	5	7,000	-	-	-	-	-	-	-	5	7,000
Devon	3	3,000	-	-	-	-	-	-	-	3	3,500
Wilsontown	2	- -	-	-	-	-	-	-	-	2	2,000
Omoa	2	2,500	-	-	-	-	-	-	-	2	- -
Total	22	24,500	1	-	1	-	1	2	-	27	37,500

TOTALS BROUGHT TOGETHER.

Counties.	1823. Total No.	1823. Quantity made.	Erected in the years 1824	1825	1826	1827	1828	1829	1830	1830. Total No.	1830. Quantity made.
		Tons.									Tons.
South Wales	72	182,325	12	7	14	2	4	-	2	113	277,643
Staffordshire	84	133,590	3	12	5	6	10	3	-	123	212,604
Shropshire	38	57,923	3	-	1	4	2	-	-	48	73,418
Yorkshire	26	27,311	-	1	-	-	-	-	-	27	28,926
Derbyshire	15	14,038	-	2	-	-	1	-	-	18	17,999
Northumberland and Durham	2	2,379	-	-	-	-	-	2	-	4	5,327
Total	237	417,566	18	22	20	12	17	5	2	333	615,917

The increase in the quantity made in the year 1830 upon the quantity made in the year 1823, is 47½ per cent.

This account of the make of iron we adopt in preference to other statements made about the same time, knowing the pains that were taken to obtain an accurate return. It is, however, defective, in the omission of the North Wales furnaces; and though it shows the number of furnaces belonging to each work, it does not show the number in blast, so that an average may be taken of the annual make of a furnace.

From various statements we find that, in

1825, the make of pig-iron in North Wales was -	13,100 tons.
1826 do. do. do. -	15,756
1828 do. do. do. -	25,168
1830 the make may be taken at about the same, say	25,000

The make will then be, in 1830: —

England and South Wales - -	615,917 tons.
North Wales - - - - -	25,000
Scotland - - - - -	37,500
Total - - -	678,417

By the same returns we also find that, in 1825, there were 364 furnaces, of which 261 were in blast, and 103 out — make 581,367 tons.

In 1828 — 367 furnaces, 277 in blast, and 90 out — make 703,184 tons.

In 1825, average per furnace - -	2,228 tons.
1828 do. do. - -	2,530

The following statement will show the quantities of pig-iron made in England, Wales, and Scotland, and also the increased make, at different periods, from the year 1740 to the year 1830: —

Years.	Tons.
1740 - - - - -	17,350
1788 - - - - -	68,300
1796 - - - - -	125,079
1806 - - - - -	258,206
1825 - - - - -	581,367
1330 - - - - -	678,417

Making the total annual increase at this period, as compared with that of 1740 — 661,067 tons.

EXPORTS OF BRITISH IRON.

Years.	Tons.
1796 to 1805, average	29,446
1806 — 1808 "	41,593
1812	57,791
1814	57,019

The official documents from 1809 to 1811, and the year 1813, were destroyed by fire.

Years.	Tons,
1815 to 1822, average	91,772
1823 — 1830 "	103,439

FOREIGN IRON IMPORTED.

Years.	Tons.
1786 to 1792 average	51,716
1793 — 1799 "	48,780
1800 — 1804 "	40,210
1805 — 1812 "	24,506
1814	22,645
1815 to 1822, average	13,995
1823 — 1830 "	17,015

FOREIGN IRON EXPORTED.

Years.	Tons.
1800 to 1804, average	4,662
1805 — 1812 "	7,553
1814	10,281
1815 to 1822, average	6,305
1823 — 1830 "	3,910

CHAP. VII.

SPAIN.

PRIOR to the further consideration of the home trade, we will, in pursuance of the original intention, give some account of the iron trade in foreign countries; and, although the manufacture in Spain cannot be considered as a matter of any great importance in itself, we will, nevertheless, devote to it a small space in this work.

The darkness which obscures the history of the Spanish population before the settlement of the Celts, 1649, B.C., it is not the province of this treatise to discuss. The people were called Celtiberians after they had united in friendly intercourse and family compacts with the Celts or Gauls then located west of the Ebro. The indefatigable Phenicians traded with Spain at a very early period; they established colonies and built Gades, their emporium of traffic. The contests between them, their Carthaginian allies, and the Spaniards, induced the Saguntines, B. C. 216, to call in the aid of the Romans, who eventually conqured all the country and converted it into one of the richest provinces of their empire. This was not until they had warred with the Spaniards nearly 200 years, during which time mining was extensively practised, and long anterior, for it is well known that the Spaniards had, at a very early period, acquired a considerable knowledge of mining in general *; and, in the time of the

* *Pumps used in the Silver Mines in Spain.*—Sometimes, at a great depth, they meet with rivers under ground, but by art give a check to the violence of their current, for, by cutting trenches under ground, they divert the stream, and being sure to gain what they aim at, when they have begun they never leave till they have finished it; and to admiration they pump out these floods of water with those instruments called Egyptian pumps (Egyptian *cochleans*),

Romans, they had arrived at a great degree of perfection in the manufacture of arms. An ancient writer * tells us — "The Celtiberians carry two-edged swords, exactly tempered with steel; and they have daggers besides, of a span long, which they make use of in close fights. They make weapons and darts in an admirable manner; for they bury plates of iron so long under ground, until the rust hath consumed the weaker part, and so the rest becomes more strong and firm; of this they make their swords and other warlike weapons, and with these arms, thus tempered, they so cut through every thing in their way, that neither shield, helmet, nor bone can withstand them.† The military arms of the Celtiberians were early adopted by their conquerors.

invented by Archimedes, of Syracuse, when he was in Egypt. By these, with constant pumping by turns, they threw up the water to the mouth of the pit, and by this means drain the mine dry, and make the place fit for their work; for this engine is so ingeniously contrived, that a vast quantity of water is strangely, with little labour, cast out, and the whole flux is thrown up from the bottom to the surface of the earth.—*Diodorus*—*G. Booth's Translation*, p. 192.

* Diodorus.

† IMPROVEMENT OF IRON AND STEEL BY THEIR BEING BURIED IN THE EARTH.

The following is an extract from the "Chronicles of Old London Bridge," 1833:—

"An eminent London cutler (Mr. Weiss, of the Strand), to whose inventions modern surgery is under considerable obligations, has remarked that steel seemed to be much improved when it had become rusty in the earth, and provided the rust was not factitiously produced by the application of acids. He accordingly buried some razor blades for nearly three years, and the result fully corresponded to his expectation. The blades were coated with rust, which had the appearance of having exuded from within, but were not eroded, and the quality of the steel was decidedly improved. Analogy led to the conclusion that the same might hold good with respect to iron, under similar circumstances; so, with perfect confidence in the justness of his views, he purchased as soon as an opportunity offered, all the iron, amounting to fifteen tons, with which the piles of London Bridge had been shod. Each shoe consisted of a small inverted pyramid, with four straps rising from the four sides of its base, which embraced and were nailed to the pile; the total length, from the point, which entered the ground, to the end of the strap, being about sixteen inches, and the weight about eight pounds.

"The pyramidal extremities of the shoes were found to be not much corroded, nor, indeed, were the straps; but the latter had become extremely and beautifully sonorous, closely resembling in tone the bars and sounding pieces of an Oriental instrument, which was exhibited, some time since, with the Burmese state carriage. When manufactured, the solid points in question

The manufactures of Spain fell with the Roman power, and were almost annihilated while under the dominion of the Goths; but they were again revived by the genius and industry of the Moors, who formed several independent kingdoms in the centre of the country. The Spaniards, driven to the mountains, and having acquired a spirit of energy which they had not for a long time experienced, had the wisdom to profit by the example of the Moors. Possessing the mines of Biscay, and the flocks of Leon, they retained the fabrication of woollen cloths and of arms, and allowed the manufacture of leather, linen, silk, &c., to remain almost entirely in the hands of the Moors.

After the death of Philip the Second the manufactures experienced an almost instantaneous decline, which nearly amounted to an absolute annihilation of trade. This was produced by the combination of various causes — the expulsion of the Moors in 1614 — a general taste for foreign stuffs, in preference to those fabricated in the country — and the impolicy of the government in not only permitting the importation of foreign manufactures, but in laying a stamp duty, called *bolla*, upon articles manufactured in Catalonia, and a heavy tax upon silks. The effect of these measures was such, that the national manufactures were generally neglected, and in a short time almost entirely abandoned. The manufactures of

were convertible only into very inferior steel; the same held good with respect to such bolts and other parts of the iron-work as were subjected to the experiment, except the straps: these, which, in addition to their sonorousness, possessed a degree of toughness quite unapproached by common iron, and which were, in fact, imperfect carburets, produced steel of a quality infinitely superior to any, which, in the course of his business, Mr. Weiss had ever before met with; insomuch, that while it was in general request among the workmen for tools, they demanded higher wages for working it. These straps, weighing altogether about eight tons, were consequently separated from the solid points, and these last sold as old iron. The exterior difference between the parts of the same shoe, led, at first, to the supposition that they were composed of two sorts of iron; but, besides the utter improbability of this, the contrary was proved by an examination, which led to the inference that the extremities of the piles having been charred, the straps of iron closely wedged between them and the stratum in which they were imbedded, must have been subjected to a galvanic action, which, in the course of some six or seven hundred years, gradually produced the effects recorded.

cotton, linen, gloves, and swords entirely vanished; and, by the close of the seventeenth century, scarcely a vestige of the former prosperity remained. Such was the state of destitution in which Philip the Fifth found the trade of Spain when he ascended the throne in 1700. The intestine wars which accompany a disputed succession, and the low state of the national finances, prevented for a time any attention being paid to the subject of manufactures; but Philip having restored tranquillity to his dominions, and established the public revenue, induced his subjects to wear the national fabrics, and thus laid a foundation for the revival of trade, which was ably and cordially supported by his successor, Ferdinand the Sixth. This prince not only encouraged the formation of manufactories, by peculiar privileges and pecuniary assistance, but also established several at his own expense, and by giving employment to foreign artizans, induced many of them to settle in the kingdom.

By the following returns it appears that a few years after Philip the Fifth came to the throne, the manufacture of iron was considerable, at least it may be considered so, for that period. The quantity of iron exported to Great Britain was, from the year 1711 to 1718, inclusive — 12,501 tons; being an average on the 8 years, of about 1560 tons.

From the year 1729 to 1735, 12,409 tons; being an average on the 7 years, of 1770 tons.

From the year 1750 to 1755, inclusive:—5818 tons; being, upon the average of the six years, 970 tons per annum.

From which period the trade in iron with Great Britain continued to decline in quantity; and in —

1786 - - -	only	50	tons were exported.
1787 - - -	„	146	„
1788 - - -	„	244	„
1789 - - -	„	69	„
1790 - - -	„	104	„
1791 - - -	„	76	„
1792 - - -	„	273	„
1793 - - -	„	45	„
1794 - - -	„	64	„

when the exportation ceased entirely.

Laborde, in his view of Spain, in the early part of the present century, informs us that the principal iron factories and forges of Spain are in Catalonia, Aragon, the three provinces of Biscay, and in the Asturias. Eleven are enumerated in the Asturias; fifteen in Guipuscoa; sixteen in Biscay Proper, which manufacture annually about 100,000 quintals *; twenty-five in the district of St. Andero alone, which annually produce 24,000 quintals. The principal forges of Aragon are those of St. Pedro, in the territory of Albarrazin, Origuela, Xea, Torres, and Tormon. There are manufactured in each district, on an annual average, about 2500 quintals.

It would appear, from a report made to the deputation, or junta, of the province of Biscay, in 1827, on the state of the iron manufactures, that they were then very much depressed, hardly, in any instance, paying the expenses. This report was, however, made in the view of inducing government to prohibit the introduction of any iron, except that of Biscay, into the other provinces, and it may, therefore, be fairly presumed that it is a good deal exaggerated. In 1828 the iron manufactories were in considerable activity. They are very numerous; but none of them are on an extensive scale, generally employing only four or five workmen. There is only one smelting manufactory at Bilbao, and both funds and workmen seem to be wanting to conduct this operation on any considerable scale.

In almost every village in the three Biscay provinces there are manufactories of some kind of iron ware; horseshoes, coarse locks, fusils, and bedsteads, are the leading articles with which they supply the interior. A number of mules pass daily through Vittoria for the interior, carrying each

* Every province has its own particular weights, but in the kingdom of Castile the pound generally consists of sixteen ounces, and of twelve in the kingdom of Aragon.

	lb.	oz.
The quintal of Castile is - - -	100	0
„ Galicia - - -	125	0
„ Biscay - - -	154	13
„ Guipuscoa - - -	105	$15\frac{7}{8}$
„ Aragon - - -	111	$1\frac{2}{3}$
„ Valencia - - -	126	0
„ Catalonia - - -	91	0

about 200 lb. weight of horseshoes. Government has an establishment in Valencia for the manufacture of muskets, pistols, and sabres. There is another at Durango, carried on by private individuals.

There is a general complaint of the increasing scarcity of wood for fuel, and of its consequent advance in price. The coal mines nearest to Biscay are in Asturias, at Aviles and Gijou, but coal is hardly used in the manufacture of iron. It appears, from a report made by the Intendant of Asturias, in January, 1828, relative to a request made by a company established for the navigation of the Tagus, for permission to import foreign coal for the use of the steam-vessels they propose employing, that these mines are of great extent and very rich.

The lowest price at which coal can be put on board at Gijou and Aviles, varies, according to this report, from 13*s.* 6*d.* to 15*s.* 6*d.* per ton of 20 cwt.

The inquiries made by a committee of the junta of Biscay, in 1827, show an extraordinary variety in the cost of extracting the ore, as well as in the proportions in which ore, labour, fuel, &c., enter into the cost of iron.

	Per cent.
For every 100 lb. of iron, the ore is valued differently, at from	$14\frac{2}{7}$ to $27\frac{1}{9}$
Fuel	$52\frac{1}{6}$ to $68\frac{10}{11}$
Workmen and labour	$1\frac{3}{5}$ to $10\frac{3}{5}$
Rent of buildings	$6\frac{1}{3}$ to $10\frac{3}{8}$

The exportation of iron ore is prohibited, but considerable quantities are, notwithstanding, sent to France. It does not appear that any of the manufactured articles are exported. A small quantity of iron in bars is exported to Bayonne and Bordeaux.

The average make of iron may be considered about 175,000 quintals, or nearly 8000 tons a year.

Although the quantity of iron made in Spain is so trifling as to be totally inadequate to supply the consumption, yet the importation of foreign iron is nearly interdicted by the present narrow policy of the Government, which it is evident must

prove very injurious. The following circular speaks strongly upon the subject: —

"The general deputation of the Lordship of Biscay (Señorio de Viscaya), wishing to prevent the pernicious abuse that may be committed by the introduction of foreign iron, which has already commenced in great quantities, the said general deputation, applying to this patriotic and important object the faculty confirmed to Biscay, by the order published by the Royal Council on the 29th of January, 1836, to levy additional duties upon articles of consumption when the ordinary duties were insufficient, has adopted the following measures: —

"Art. 1. All foreign iron that may be introduced into Biscay will, immediately on its being landed, be taken direct to the bonded warehouse of the deputation.

"Art. 2. After having been duly deposited in the bonded store, it will continue in the custody of the storekeeper.

"Art. 3. The bonded iron may be freely exported from Biscay, with a permit from the judge of contraband (Guia), on payment to the general deputation of eight maravedis per 100 lb. for store room, should the time of its remaining in store not exceed one year; double that sum, should the time not exceed two years, and so on; and eight maravedis per 100 lb. for weighing.

"Art. 4. The general deputation will adopt measures to prevent foreign iron from being smuggled into the country, on its way from the bonded stores to the line of the Ebro.

"Art. 5. Foreign iron imported for consumption in Biscay will pay to the general deputation, on being removed from the bonded warehouse, a duty in accordance with the following tariff: —

	Rials.
Forged iron in bars, bolts, &c., per Castilian quintal - -	70
Sheet iron, per ditto - - - - - - - -	30
Hoops for casks (not exceeding one line in thickness), ditto	3
Worked in locks or padlocks, per lb. - - - - -	7
Files, chisels, hatchets, hammers, pincers, spades, tridents, &c. for each dozen pieces - - - - - - - -	8

	Rials.
Smoothing irons, per lb. - - - - - - - -	5
Steel in bars, or wrought, per lb. - - - - - -	1
Steel in thin bars, for watchmakers' use, per lb. - -	3

(Signed) Fredrico Victoria de Lecea.
Manuel Maria de Musga.
Manuel de Barandica, Sec. *ad int.*

Bilbao, April 16, 1840.

By a law passed in 1841, pig-iron is allowed to be imported on the following terms:—

Government Duty,

If in Spanish ships, 6 rials per quintal.
If in Foreign ships, 8 „ „

Port Charges, 2 rials.

The export of iron in 1849 amounted to 25,940 quintals—nearly 1300 tons. Dr. Ure says that the iron mines of the Pyrenees keep in activity 200 Catalonian forges.

CHAP. VIII.

SWEDEN AND NORWAY.

SWEDEN has been long celebrated for its mines and mineral productions, particularly iron, which still forms one of the principal exports, although it has much decreased of late years. By an account taken by the government in the year 1748, we find that, at that time, there were 496 foundries, with 539 large hammers, and 971 small ones, for making bar and other manufactures of iron, which produced 304,415 ship-pounds*, or nearly 40,600 tons.

The government established an office in 1740 to promote the production of iron, by lending money on the ore, even at so low a rate as 4 per cent.; a correct register was then made of the mines, which is still continued. Each forge has its particular mark stamped on the bars of iron it produces, which is correctly copied into the manuscript, with the name of the place where the establishment is situated — the names of the proprietors of the work — the commissioner or agent for the sale of the iron — the assortment each makes, and to what country it is generally shipped — the quantity annually made by each work — the quantity which each work delivers to the government (which is about 1 per cent. on the quantity of the iron produced) — the estimation of the quality of the iron of each work, which is variable — the place and province in which the works are situated — the place from whence the iron is generally shipped, and how many hammers each work has: all which particulars are regularly and alphabetically described and arranged.

As the working of the mines is attended with considerable expense, and the sale of the iron uncertain, the Bank of Stockholm receives that metal as a proper security for a loan. The iron being duly appraised, and lodged in the public ware-

* 7½ to a ton.

house, the proprietor receives three-fourths of its value, at the interest of 3 per cent., and when he can find an opportunity to dispose of his iron, it is again delivered to him, on producing a certificate from the bank, that the loan upon it is duly discharged.

The iron mine of Dannemora, the most celebrated in Sweden, is situated in the province of Upland, about one English mile from Osterby, and thirty English miles north of Upsala. This mine was discovered in the year 1448, and though it has now been wrought for four centuries, it still yields abundance of the best iron in Europe.

The iron mine is on a hill so little elevated above the surface of the neighbouring country as easily to escape observation. It is about two English miles long, and nearly half a mile broad; it is almost surrounded by lakes—those of Dannemora, Films, and Grüfve, lying quite contiguous to it. On the side where there are no lakes there is a turf moss. The ore forms a large vein in this hill, which stretches in a north-west and south-east direction. The mine was some years ago inundated by the water from the adjacent lakes; a strong wall, however, has been built to keep off the water. It is drained by two steam-engines, kept at work by means of wood for fuel.

It was first wrought as a silver mine, the silver being extracted from galena. This source of emolument soon failing, or becoming unproductive, the iron ore began to be extracted and smelted, and the excellent quality of the iron gradually drew to it the attention of the public. At first it belonged to the King of Sweden, but that monarch consigned it over to the Archbishop of Upsala as a part of his revenues; at present it belongs to a number of private individuals, who work it separately, each on his own account.

At the side of the mine is a large opening, about fifty fathoms deep and fifty wide, and at the lower part of this is the entrance to the mine, which is wrought about thirty fathoms deeper than this opening. The mines are thus described in "Coxe's Travels," who visited them in the year 1790:—"The pits are deep excavations, like gravel pits, and form so many abysses or gulfs. The descent is not, therefore,

as is usual in mines, down a narrow subterraneous shaft. At the side of the mine I stepped into a bucket, and, being suspended in the open air, in the same manner as if a person was placed in a bucket at the top of Salisbury spire, was gradually let down to the ground by a rope and pulley. The inspector accompanied me to the bottom, and while I was placed at my ease in the inside upon a chair, he seated himself on the rim of the bucket, with his legs extended to maintain the equilibrium. He had in his hand a stick, with which he gently touched the sides of the rock, and the rope of the ascending bucket, in order to prevent our bucket from swerving against them, which must have infallibly overset us.

"While hung suspended in mid-air, and so giddy that I could not venture to look down, I observed three girls standing on the edge of the ascending bucket knitting, with as much unconcern as if they had been on *terra firma;* such is the effect of custom. We were about five minutes in descending, and the depth which we reached before I stepped out of my aërial seat was 500 feet. Not being a mineralogist, my curiosity was soon satisfied; I again got into the bucket, and was drawn up in the same manner.

"The inspector informed me that the richest ore yields 70 per cent. of iron, the poorest 30; that, upon an average, the collective mass gives one-third of pure mineral; that about 12,000 tons are annually drawn from the mines, which yield about 4000 tons of bar-iron.

"The mass of ore occupies a small compass. The length of the pits, considered as one, is 760 feet, and the breadth from three to twelve. The ore runs from east to west. The richest ore is near 500 feet in depth, and the Storoe Grube is not yet fathomed.

"The matrix of the ore being a calcareous earth, consequently contains but little sulphur, which is, perhaps, the reason of its superior quality."

The ore is blasted with gunpowder. The part of the vein which lies under the great opening, which forms the mouth of the mine, is called *stor rymning;* it constitutes by far the greatest portion of the mine. The next portion is called *jord grufva* (earth mine), and it yields the ore of the very best

quality. The portion farthest south is called *sodra grufva*, or southern mine; it yields the worst kind of ore of all the three, probably from being mixed with galena and blende. The rock through which the vein runs is said to be quartz. The substance immediately contiguous to the vein appeared to Dr. Thomson to be hornstone, and to contain hornblende. The ore itself contains limestone, quartz, and actinolite, and affords from 25 to 75 per cent. of cast-iron. In the worst kind of ore Dr. Thomson also perceived blende, fluor-spar, galena, and amethyst, but in small quantities. Carbonate of lime, crystallised in dodecahedrons, also occurs in this vein; and likewise sulphate of barytes, mountain cork, and the aplome of Haüy.

The ore is broken into small pieces, and roasted; it is then put into conical-shaped furnaces, constructed of the slag from cast-iron. In these furnaces it is mixed with the proper quantity of charcoal, and then melted and separated from the slag. The cast-iron obtained in this manner is as white as silver, completely crystallised, and very brittle. The cast-iron is reduced to malleable iron by heating it in a bed of charcoal, and hammering it out into bars. In this state it is whiter than common iron, and is less liable to rust, is distinctly fibrous in its texture, and much stouter than any other iron.

The cause of the superiority of the Dannemora iron has never been explained. Some chemists ascribe it to the presence of manganese. Berzelius attributed it to the presence of the metal of silica, while others suppose it to arise from the nature of the process employed. Dr. Thomson was assured by one gentleman, who had bestowed particular attention to the subject, that by following a similar process he has obtained as good iron from other Swedish ores. But that something is due to the ore itself is evident from the circumstance, that the quality of the iron, though the same process is followed, differs a good deal, according to the part of the vein from which the ore is taken.

In the neighbourhood of the mines are establishments for forging the iron, and for the accommodation of more than 300 workmen and their families. Each of the little villages has

three or four regular streets, often planted with trees, a church, a school, and an hospital.

The whole make of iron in Sweden was, in the year 1803, 364,315 ship-pounds, or about 48,000 tons, taking 7½ ship-pounds as a ton English; in 1812 it had increased, as appears by the following table, to 431,137 ship-pounds, or about 60,000 tons.

Counties.	Iron Mines.	Produce of the ore in ship-pounds.	Smelting furnaces.	Forges.	Privileged iron works to the 15th June, 1803.		Total produce of iron in ship-pounds.
					Iron bars in ship-pounds.	Coarse iron utensils in ship-pds.	
Vesterbotten and Norbotten - -	2	2,000	4	7	2,595	- -	2,595
Wester Norrland	-	- -	5	15	9,539	1,469	11,008
Norrland -	2	- -	9	22	12,134	1,469	13,603
Stockholm - -	6	5,751	6	5	10,970	- -	10,970
Upsala - - - -	19	72,940	13	9	24,646	1,585	26,231
Vesteros - - - -	17	100,516	31	49	42,339	1,077	43,416
Nyköping - - -	12	81,482	8	22	12,854	1,946	14,800
Orebro - - - -	55	164,431	82	64	53,548	5,167	58,715
Carlstad - - - -	35	126,818	35	69	66,214	1,974	68,188
Stora Koppaberg	20	146,000	72	56	32,712	4,932	37,644
Gefleborg - - -	6	21,168	30	47	43,365	905	44,270
Svealand - -	170	- -	277	321	286,648	17,586	304,234
Linkoping - - -	3	3,000	13	25	13,693	1,906	15,599
Kalmare - - - -	-	- -	10	13	6,505	- -	6,505
Iönköping - - -	1	8,000	14	11	4,775	517	5,292
Kronaberg - - -	-	- -	13	10	3,366	323	3,689
Skoraborg - - -	-	- -	2	9	6,043	112	6,155
Elfsborg - - - -	-	- -	-	10	5,289	3,949	9,238
Götaland - -	4	- -	52	78	39,671	6,807	46,478
Total - - -	176	- -	338	421	338,453	25,862	364,315
New works since 15th June, 1803	-	- -	-	-	47,257	19,565	66,822
Total - -	-	- -	-	-	385,710	45,427	431,137

In 1833 there were in the whole of Sweden from 330 to 340 smelting furnaces, producing 90,000 to 95,000 tons of pig-iron; in converting this into bar-iron, about 23 per cent. is allowed for waste, and as near as can be ascertained the annual manufacture of this latter is 63,000 to 65,000 tons. The number of iron works is about 420 to 430, having about 1100 forge-hammers. The annual export of bar-iron, on an average of ten years, ending 1831, was 49,568 tons. The smelting furnaces and iron works are licensed for a particular quantity, some being as low as 50 tons, others as high as 400 to 500 tons per annum; some few bar-iron works draw licenses for 1000 tons each. The licenses are granted by the College of Mines, which has a control over all iron works and mining operations. The iron-masters make annual returns of their manufacture, which must not exceed their privilege, on pain of the overplus being confiscated, and the college has subordinate courts, called courts of mines, in every district, with supervising officers of various ranks; and no iron can be sent to any port of shipment without being landed at the public weigh-house, the superintendent of which is also a delegate of the college, and his duty is to register all that arrives, and to send his report quarterly to the college. It is impossible for an iron-master to send to market more than his license. Many, however, sell at the forges to inland consumers, returns of which are never made, and so far licenses are exceeded, but it is supposed this excess cannot be above 3000 tons.

There is no chance whatever of the manufacture of iron in Sweden becoming free; on the contrary, there is much greater probability of its decrease, as in those parts of the country where iron works are established there are already as many forges as the neighbouring forests can supply with charcoal. If there are proprietors of forests on which they can prove that iron works have not been privileged in former times, in that case the government cannot refuse to grant the right of erecting works in proportion thereto; but, except either very far north, or far in the interior, there do not exist such woods.

It does not always follow that the forests belong to the pro-

prietors of the iron works, but they have, nevertheless, the right of purchasing all the charcoal sold from these woods. We may consider the case in this manner:— A person, a century back, who had 20,000 acres of forest, may have obtained the privilege of manufacturing 200 tons of iron annually; the estate in the lapse of time has become divided amongst a number of heirs, or has been sold in lots to different persons; but the proprietor of the iron works still retains the right to the charcoal of the whole, if any is made, for sale.

There is no department in Sweden conducted with more fairness than the College of Mines, which manages these matters.*

	Average Produce.		Average Exports.
Years.	Unwrought Iron. Tons.	Bar-iron. Tons.	Bar-iron. Tons.
1833 to 1839 - -	89,610	73,592	58,766
1840 — 1844 - -	105,485	84,041	66,046
1845 — 1849 - -	106,630	90,466	74,069
1850 — 1852 - -	124,169	99,889	75,940

Important recent discoveries have had, and necessarily will have, a material effect on the iron manufacture of Sweden. Dr. Ure may introduce the subject to our readers in the following observations respecting Mr. Heath's experiments in the manufacture of *steel* and their results: —

"One of the greatest improvements which this valuable modification of iron has ever received is due to Mr. Josiah M. Heath, who, after many elaborate and costly researches upon both the small and the great scale, discovered that, by the introduction of a small portion (1 per cent., and even less) of carburet of manganese into the melting-pot, along with the usual broken bars of blistered steel, a cast-steel was obtained after fusion, of a quality very superior to what the bar-steel would have yielded without the manganese, and moreover

* In several parts of Lapland, the protoxide of iron occurs in great beds, or immense masses: at Gillivara, 200 leagues north of Stockholm, towards the 67th degree of latitude, it constitutes a considerable mountain. The iron is despatched in small sledges drawn by reindeer, to streams which fall into the Lutea, and thence, by water carriage, to the port of Lutea, where it is embarked for Stockholm.

possessed of the new and peculiar property of being weldable, either to itself or to wrought iron.

"He also found that a common bar-steel, made from an inferior mark or quality of Swedish or Russian iron, would, when so treated, produce an excellent cast-steel. One immediate consequence of this discovery has been the reduction of the price of good steel in the Sheffield market by from 30 to 40 per cent., and likewise the manufacture of table-knives of cast-steel with iron tangs welded to them; whereas, till Mr. Heath's invention, table-knives were necessarily made of shear-steel, with unseemly wavy lines in them, because cast-steel could not be welded to the tangs."

Mr. Heath obtained a patent for this and other kindred meritorious inventions on the 5th April, 1839, "but, strange and melancholy to say," observes Dr. Ure, "he has never derived anything from his acknowledged improvement but vexation and loss, in consequence of a numerous body of Sheffield steel manufacturers having banded together to pirate his patent, and to baffle him in our complex law courts." Whether the remarks on the conduct of the steel manufacturers of Sheffield are just, is not important to this inquiry; the fact is, that various alterations and improvements have been effected in the manufacture, not confining it to the use of Swedish or Russian inferior marks, but to the use of English iron, and this to the extent of attracting the notice of Mr. C. F. Wœrn, Junior, a member of the Swedish Diet, who made it the subject of a motion in the Diet, 1853-1854:—"On the repeal of the taxes on pig and bar iron, as well as of the privileges still existing in favour of the mining districts and iron works of Sweden."

Mr. Wœrn, in his Treatise—after a review of the iron trade in Sweden during the last twenty years, and arriving at the conclusion that the home consumption has certainly been on the increase, owing to the general growth of population and trade between the years 1834 and 1851—says: "Yet, in comparison to the population, the consumption per man is very much smaller than in other civilised countries; accurate

calculations on this subject show the following results — all kinds of iron being reduced into pig-iron: —

In North America the consumption is - -	88 lbs.	per head.
Great Britain - - - - -	81	„
France - - - - - - - -	36	„
Hanover and Oldenburg - - -	29	„
German Customs' Union - - -	24	„
Switzerland - - - - - -	18	„
Sweden - - - - - - -	$11\frac{1}{2}$	„
Austria - - - - - - -	11	„
Russia - - - - - - - -	8	„

At present there is reason to believe that the Swedish consumption is 14lbs. per head."

He then speaks of the exports of bar and manufactured iron from Sweden, which, during the same period, he calculates to have increased about 25 per cent.

In order to show the insignificance of this increase, in comparison to that which has taken place in other countries, he reviews the trade, and speaks more particularly of the discoveries and improvements made from 1796 to 1851 in Scotland, and observes: " Instead of having been, as before these discoveries and improvements were made, only two-fifths of the Swedish production, it rose in Scotland in ten years to double the Swedish production, and is now six times as large. In Wales we notice the same thing, as well as in the United States, Belgium, Silesia, the German provinces on the Rhine, and even France. If we compare the countries which chiefly produce iron for the last twenty years, we find that

Great Britain - - -	increased in	1850	244	per cent.
United States - - - -	„	„	471	„
France - - - - -	„	1846*	141	„
Russia - - - - -	„	1849—1851	20	„
German Customs' Union -	„	1850	60	„
Austria - - - - -	„	„	130	„
Belgium - - - - -	„	„	217	„
Sweden - - - - -	„	„	51	„
Norway - - - - -	„	1841—1845	62	„

and thus the production has increased more rapidly in every

* Mr. Wœrn states the make of pig-iron in France, in 1846, as 2,742,521 ship-lbs. T. v., equal to 457,087 tons.

country than in Sweden, with the single exception of Russia. Now, if we compare the total production of these countries twenty years ago, and that of Sweden at the same time, with what it is now, we find that the production of this country has suffered a decrease from $\frac{1}{16}$ to $\frac{1}{32}$."

He then goes on to the more important subject of the manufacture of English steel. He says: "I have found it impossible to obtain trustworthy information as to the amount of manufacture or consumption of English steel-iron; but to a certain extent such a guide is found in the number of steel furnaces in Sheffield and the neighbourhood. I have had returns made at four different periods. The first, of 1835, is found in Porter's 'Progress of the Nation;' the second, of 1842, is given by Professor Le Play, in his excellent treatise on the manufacture of steel in Yorkshire; the third is of the year 1846, and is part of the evidence of one of the largest manufacturers of Sheffield, Mr. Henry Unwin, before a Committee of the House of Commons, on the occasion of a railway being applied for to Sheffield; and the fourth is the result of an account taken at my request by the same gentleman, in July this year, of existing furnaces, in which he says he is so much the more sure of not having overstated the case, as he has separately noted the owner and situation of each furnace.

"According to these statements, there existed, in Sheffield and the immediate neighbourhood, in

1835,	56	blistered-steel furnaces, and		554	cast-steel furnaces,
1842,	97	„	„	774	„
1846,	105	„	„	974	„
1853,	160	„	„	1,495	„

"The new furnaces are built rather larger than the old ones, and Mr. Unwin estimates their capacity of production at 300 tons annually, and the total production of steel in England at 40,000 tons.

"Porter estimates the manufacture of steel in Sheffield in 1835 at 15,000 tons, of which 2000 tons were from English iron. The same amount is given by Mr. Danielson, in his

Treatise on the Manufacture of Steel in England in 1844. Mr. G. Ekman, in his letter which refers to Professor Le Play's work, estimates this production of 1845 at 3000 tons; and, according to Mr. Unwin's statement, giving 40,000 tons as the annual production of steel in England, it must now amount to 7200 tons, when the whole import of foreign iron not re-exported has been deducted. *The English steel-iron is moreover universally known for its closeness and pureness, and some of the best sorts are so much liked, that they fetch a higher price than the best Swedish marks.*"

Thus much as to the competition of British iron with Swedish, in Great Britain, for the manufacture of steel. He then refers to the export to other countries, and shows that of Great Britain to be five or six times as large as it was, whilst that of Sweden has been almost stationary,—"that the latter amounted to almost one-half of the export of Great Britain twenty years ago, and in 1850 it was scarcely a tenth part of it, and must since then have fallen off still more."

The object of Mr. Wœrn's motion was to alleviate, if possible, this state of affairs, by inducing the Government to remove all taxes and restrictions on the manufacture of iron. But the greatest difficulty Sweden has to contend against, as far as the increase of manufacture is concerned, is *the want of coal.*

Now comes a consideration, whether, with the immense abundance of rich ore which Sweden possesses, there are not certain localities where it may be shipped at a low rate of cost. Let the Swedish Government take off any heavy restrictions on the export of this ore, and a valuable trade may be encouraged between Gottenborg, or other shipping ports, and the port of Newcastle, thus bringing the ore to the coal, and a more certain benefit might be derived by Sweden than by an attempt at any great increase of the manufacture.

NORWAY.

Oddy, in his work on "European Commerce," observes, that iron makes no regular article of export from Norway; yet there does not appear any reason why they might not have cultivated this branch of manufacture as well as Sweden. Wood they have in sufficient abundance. There are several foundries in Norway, but they have not been worked with spirit; their produce is therefore but small. Since the year 1792, they have not much extended their works. Moss, a town of a thousand inhabitants, contains a principal iron work. Skaggerak is also in repute for its iron trade.

The iron mines of Norway lie on the coasts of the Gulf of Christiania, and on the side facing Jutland, principally at Arendal, at Krageroe, and the neighbourhood. The ores consist almost solely of black oxide of iron, which forms beds in veins of from 4 to 60 feet thick, incased in gneiss. These iron ores are reduced in a great many smelting forges situated on the same coast, and particularly in the county of Laurwig. The annual product is about 7300 tons, in the form of cast-iron, bar-iron, sheet-iron, nails, &c., of which one-half is exported.

AVERAGE MAKE OF BAR-IRON.

Years.	Tons.
1831 to 1835	3,645
1836 — 1840	3,898
1841 — 1845	3,772

Average export, about 2,050 tons.

CHAP. IX.

RUSSIA.

Of the vast tract of country now comprehended under the appellation of Russia, we glean from ancient authors little that tends to illustrate the early history of iron.

The Scythian nations, from their mixture of rude, pastoral, and warlike habits, cannot be expected to supply posterity with their own history; we, therefore, are indebted to other sources for such information. The Greek authors do not much enlighten us in our researches after the extent of knowledge which the Scythian nations had of the useful arts, nor as to the extent of advantages they derived at that remote period, from the riches of their inexhaustible mineral soil.

The literary records of China may, when explored, open, at some future day, many interesting facts in the history of the Scythians, Tartars, and Russians; their early trading, and extent of their knowledge. It is much to be lamented that so vast a field of antiquity as China has not yet been fully explored and ably gleaned. In that isolated empire, the arts and sciences flourished for ages anterior to the era of our Lord. Sematsien, who wrote his valuable history of China, 97 B. C., dates his authentic chronology from 841 B. C. After about six centuries (in which war and anarchy held sway), we arrive at the bright period of *revival* of learning and improvement in letters, by the invention of paper and printing; about 206 B. C. We may also mention that about this time the great wall was built, mainly as a defence against the nations at war with China; the latter, by the adoption of the improved nature and quality of the arms of her opponents,

became victorious, the cuirass and lance being now of common use. This brief notice, we conceive, justifies our expectation that China possesses much which we think may enlighten the industrious inquirer. The immense value of iron as material for arms, was manifest wherever introduced, and its great superiority over other metals so employed immediately commanded attention. Those nations who had previously been ignorant of its manufacture, seeing its utility, would at once become eager to obtain it and learn the method of procuring it from their own soil. Such reverence did the Scythians pay to a sword of iron, that they worshipped it as the shrine of Mars.—Herodotus, lib. iv. Again, we learn from the same source, that "the Massagetæ had all their arms, their spears, arrow-heads, battle-axes, helmets and breast-plates of *brass* decorated with gold; they use neither silver nor *iron,* which indeed their country does not produce." "The Scythians," he says, "possess neither silver nor brass."—Lib. lxiv. 71.

The ancient writers knew little or nothing of the north parts of Scythia, or the region of Siberia, in later times found to be immensely stored with valuable minerals, and surpassingly rich in ores of iron.

In Siberia, at a time reaching back beyond all history, mining was vigorously practised by a nation bearing the name of Tschudes, whom Georgi takes to be the ancient Mandshures: an interesting account of the mine works of this nation may be read in Pallas' Travels, tom. iii. pp. 608—610.

Thus, Russia, we see, was possessed of iron ores from time immemorial, but previous to the reign of Ivan Vassillievitch history says nothing of any regular mining operations. This prince, in the year 1491, sent two Germans to the river Petschora, on mineral discoveries, who were so fortunate as to find silver and copper ore. During the reign of Ivan Vassillievitch the Second, the English, by a treaty concluded in the year 1569*, obtained the privilege of seeking for and

* The communication with Muscovy had been opened in Queen Mary's time, by the discovery of the passage to Archangel, but the commerce to that country did not begin to be carried on to a great extent till about the year 1569.

smelting iron ore, on condition that they should teach the Russians the art of working this metal, and pay, on the exportation of every pound, one denga, or halfpenny.*

The first regular mine works, which may be properly so called, were established about ninety versts from Moscow, by two foreigners, who, in the reign of the Czar Alexy Michaelovitch, were at Moscow, on commercial affairs, and had found ore in that territory;—they requested, and obtained permission to work it.

These works, the first and only ones in Russia prior to Peter the Great, were visited by that monarch, who wrought in them himself before he set out, in 1698, on his first journey into foreign countries. Remaining some time in Saxony, he not only made himself acquainted with the arts of mining, but requested the king of Poland to give him some workmen; and, in the following year, twelve of them, with a master at their head, and the assayer, Bluher, went to Russia, where they found ore in the districts of Kazan and Kalula, and began to work. The emperor, however, finding that with these two establishments he should be in want of people, sent Bluher, in 1701, again to Saxony, who returned in the same year with several persons skilled in mining, and repaired immediately to Olonetz, where they opened a mine of copper ore. The subsequent journeys of Bluher gave the first occasion to the discovery of the Siberian minerals, for, in the year 1703, he was dispatched to the Permian mountains, near Solikamsk, where he found an old mine; whence he proceeded

The Queen (Elizabeth) obtained from the Czar (John Basilidus) an exclusive patent to the English for the whole trade of Muscovy. After the death of John Basilidus, his son Theodore revoked the patent which the English enjoyed for a monopoly of the Russian trade. When the Queen remonstrated against this innovation, he told her Ministers that princes must carry an indifferent hand, as well between their subjects as between foreigners, and not convert trade, which, by the laws of nations, ought to be common to all, into a monopoly, for the private gain of a few. So much juster notions of commerce were entertained by this barbarian than appear in the conduct of the renowned Elizabeth! Theodore, however, continued some privileges to the English, on account of their being the discoverers of the communication between Europe and this country.—*Hume.*

* Of the first arrival of the English, and the origin of their commerce, there is an account in the "St. Petersburgh Journal," vol. ix. p. 149.

further along the Kama, and soon after his return to Moscow, made a fresh journey in the districts of Azof, Astrachan, and pushed forward to Caucasus.

In the meantime the emperor had appointed Lieutenant-Colonel Henning to be director of the mines of Olonetz — a foreigner of great activity, who restored the old ruinous iron works, and put them in a condition to furnish the newly-created navy with large and small cannon, and other iron ammunition. In the year 1719, Henning travelled through several countries of Europe, for the purpose of collecting information concerning the state of the mines and foundries; and, on his return, got together, by permission of the Kings of Poland and Prussia, a considerable number of master workmen, by whose assistance he set up several wire manufactories, forges for steel, hammers for tin plates and making iron bars, steel furnaces, anchor smithies, and other engines, all worked by water.

As it appeared, from the accounts delivered in, that ore was to be found in almost every part of the empire, Peter the Great, in the year 1719, constituted a peculiar mine college*, and shortly after sent Major-General Henning, whom he had promoted for his useful services, in quality of director, to Siberia, for the purpose of completing the works already begun there. Henning established a chief mine office at Ekaterinburg, and a subordinate office in the territory of Perm; he also built several work-shops, furnaces, forges, foundries, and mills for flattening and slitting; and within the space of six years, had made such progress in all these works, that the various expenses attending them were repaid, with interest, by the metals obtained. In the years 1726 and 1727, he sent annually 140,000 to 150,000 poods† of bar-iron, besides a great quantity of other kinds of wrought-iron, by means of the water communication from Siberia to Moscow. These services procured him the rank of lieutenant-general

* On the 1st of May, 1784, the mine college came to an end, being dissolved by an ukase, bearing date January 27. 1783.

† Sixty-three poods to a ton, or 2268 lbs. English.

of the artillery, and the post of general director of all the copper and iron works in Siberia.—(*Schlœtzer, from Von Haven*, pp. 85—92.)

The art of mining, which, properly speaking, had taken its rise under Peter the Great, was thus, by the wise and unwearied exertions of that prince, encouraged and advanced in all imaginable ways. In the year 1716, the emperor, by a manifesto, had given his subjects the first encouragement in mining. In three years afterwards he instituted the college of mines, and, "as his empire was full of subterranean treasures, and these rich sources of subsistence were hitherto neglected, partly from ignorance, and partly from the insecurity of the possession," he found it necessary, with the view of encouraging the search after ores, and the working of mines, to establish several remarkable privileges. By an ukase of the year 1720, these privileges were extended to all foreigners without distinction. Other ordinances, of similar purport, enjoined that persons who were searching for ores should have no impediments thrown in their way—that the woods about the works should be kept up—and that, for the protection of the mines, fortresses should be constructed on the frontiers.

Such was the state of the Russian mines when Peter the Great quitted the stage on which he had laboured so much, and with such great success.

Akinfy Demidof, a wealthy individual, and the father of the Uralian mine works, in 1725, received intelligence of the Tschoudian mines in the mountains of Kolyvan, and caused them to be visited by German miners, whom he had employed at former works. As here were found very rich veins of copper ore, he erected some works in the year 1727, adjoining to the Lake Kolyvan. The number of his labourers was soon increased by people who had run away from the estates to which they belonged, whom he, by a special privilege, might admit and employ in his works; and a considerable number of crown boors were at the same time granted him.

In the reign of the Empress Anna, the iron mines began to be of such consequence, that, in order to gain the preference

from the Swedish iron, the price of the Russian was fixed at 56 copecs* the pood.

The mine undertakings of private individuals met with every needful encouragement. Whoever discovered a mine, and was inclined to work it, was allowed to make the proper dispositions in erections, diggings, &c., for which he was granted ten years free; the adventurer was put in possession of the property of the ground as a freehold, provided it belonged to the crown†, with convenient places on the banks of streams and rivers for the works and necessary buildings, and a considerable extent of forest; and when he had no boors of his own that he could set to work, he received a certain number out of those raised for recruits, who were to remain, as well as their posterity (*adscriptus glebæ*), with the works. If these proved insufficient, other boors were given him to perform the occasional labours in lieu of their head-money, which the owners of the works were obliged to pay in their stead. In all private undertakings of this sort, the crown retained certain *imperialia.*

1st. A yearly tax on every furnace—for the principal one in iron works 100 rubles.‡

2nd. Of crude iron, one-tenth.

3rd. All sorts of vessels for the artillery and the admiralty, for a stated price, settled in 1715 and 1728.§

* One hundred copecs to a ruble.

† The crown has occasionally not merely granted one of its mine works, but has regularly sold it to a private individual. Thus, one of three iron works, and that a very productive one, was purchased, with all the people belonging to it, pits and erections, together with a considerable forest, for 200,000 rubles, as we are informed by Professor Pallas, who also mentions another in similar circumstances. The crown has also bought some of them back again.

‡ A ruble, 4*s.*

§ The Empress Catherine the Second, by several edicts, relinquished the *imperialia,* and abolished the taxes. The delivery for the admiralty and artillery was given up in 1770, and, as an act of grace, on occasion of the peace of 1775, the tenth of the capital of the minerals, as well as the tax on the furnaces, with the tenth of the raw iron, were remitted.

The tribute or taxes attached to private mines, altered by the ukase of the 28th June, 1780, are the following:—

1st. Instead of the tenths on each pood of raw iron, four copecs were paid. Since the 23rd June, 1794, all iron works erected with the assistance of the crown pay an additional four copecs, and those without that assistance two copecs.

In regard to the workmen, it has just been observed, that, at first, it was the practice to assign a certain number of crown boors to private adventurers, many of whom, being of the class of merchants, had no vassals, and could not procure any voluntary workmen; those labourers were to work out their head-money in that capacity; but, from this method, oppression arose — the people were allowed no respite from labour, and hardly any recompense. During the reign of the Empress Elizabeth, these men, no longer able to bear the oppression under which they groaned, rose against their employers, and the government was obliged to send some regiments of soldiers to suppress the insurrection. Many most distressing scenes occurred in consequence, which were finally put a stop to by the Empress Catherine the Second, who, on ascending the throne, immediately adopted measures for checking the flagrant proceedings of the masters.

In the year 1766 she appointed a commission, composed of the chief officers of state, to examine into the matter, and to lay before her their proposals for an alteration; but as there was no hope of a termination to this weighty concern, it being delayed by every kind of difficulty that could be thrown in the way, the empress issued some special precepts from her own hand, whereby the grossest of the abuses were remedied for the present — till at last the laudable ordinance of the 23rd May 1779 appeared, by which the fate of the enrolled boors was fixed on a humane and equitable footing.

At the crown mines of Barnaul, besides their own people they employ about 48,000 boors, who earn their head-money there—these people were always well treated.

The mines of Schlaugenberg, and in general the Barnaul, are in all respects of great consequence. They have ironstone that yields 50 to 60 per cent. Herman speaks even of 70 per cent., but most commonly it is 25 per cent.

In the Uralian mountains, in the year 1779, there were

2nd. For every forge, the owner pays the crown 200 rubles yearly. Until the 23rd June, 1794, only 100 rubles,—at which time the tax was doubled.

3rd. The duty on exportation on every *berkovetch* (ten poods) of bar-iron is thirty-seven copecs. *Tooke*, 1799.

generally at work 70 forges and 532 large hammers, besides two smelting-houses, in the Altaian and Sayansk mountains, and several in the governments of Olonetz, Vologda, Nisney-gorod, Kostroma, Kursk, Tula, Tambof, &c. In 1798 there were in the whole empire about 100 forges and 800 hammers; but, besides these large iron works, there are a great many smiths, who smelt the ore at home, and of the iron make various kinds of utensils. Such little smithies are principally in the governments of Olonetz and Archangel — in some regions of the Volga, and in Siberia, near Krasnoyarsk, Yenisiesk, &c.

The produce of the mines at the Uralian iron works of the governments of Perm, Ufa, and Winska, amounted, in the year 1782, to 3,940,400 poods of wrought-iron; and, as we may allow for all the other Russian and Siberian governments at least a million of poods, the total quantity of iron manufactured will be about 5,000,000 poods*, independent of the various cast wares, which are not included. To obtain this quantity of wrought-iron, it requires from seven and a half to eight million poods of raw iron. The average produce of iron, from the year 1779 until 1793 or 1794, was about 80,000 tons annually, of which about one-half was exported, and to that end conveyed to St. Petersburgh, which, even from the Ural, notwithstanding the great distance, is done almost throughout by water.† The expense of this transport, which is greatly favoured by the rivers and lakes of the Uralian territory, comes to, for the greatest part, from fifteen

* The largest iron works belong to the families of Demidof, Yakovlef, Stroganof, Iverdischef, Lazaref, Luginin, and Bateschef. The family Stroganof possesses, in the government of Perm alone, 540,000 square versts of land, and had on it, at the revision before the last, 83,453 vassals of the male sex. Of the private works and villages there are many which, in magnitude, in neatness of buildings, and in the number of their inhabitants, exceed most of the towns in this government.—*Tooke*, 1799.

† This navigation first commences on the borders of China, passing by the Selivga to the Baikal Lake, from thence, upon the Angara into the Yenesei, as far down as Yenesei; there the iron is unloaded, and carried over a short tract of land, and embarked on the river Ket; from thence, down that river, into the Ob, from which, up the Irtish, the Tobol, and thence overland to the Tchussovaia; upon which river it is embarked again, and goes into the Kama, and the Kama into the great river Volga.—*Oddy*.

to twenty, for some above twenty, and for a small proportion about twenty-five copecs the pood. With the majority of the Uralian iron works the pood of iron delivered at St. Petersburgh did not cost more than fifty-five, or, at the most, sixty copecs the pood. The other half was used in the interior and at the various manufactories—the cast-iron is principally disposed of to the Asiatic nations.

The manufactures increased by the prohibitions that took place in 1794, when the importation of all hardware was prohibited (scythes excepted), which the Russians could not make in sufficient quantities. The following is a statement of the manufactures about the year 1798 : —

" *Iron Foundries.*—Almost at every iron mine, where there is a forge, cast-iron ware is prepared in clay and sand, various sorts of pans, pots, kettles, and other domestic utensils, as also such as are wanted at the mines and manufactories. At almost all the mines, particularly at those belonging to the crown in Siberia and at Olonetz, they cast cannon and other implements of artillery. At Petrozavodsk, in the government of Olonetz, is a grand cannon foundry, where iron cannons are cast, of excellent workmanship, by means of a cupola furnace. The principal castings hitherto produced by the Siberians are some masterly balustrades and railing, with a few statues, cast at the foundry of M. Demidof.*

* The history of the origin and wealth of this most respectable family, and of their possession of such productive mines, is not destitute of interest, and I believe to be correctly as follows :—" The Demidofs are descended of a very industrious working miner, who had a small iron mine on the confines of Siberia. This was the great grandfather of the present generation. Peter the Great, on visiting the spot, upwards of a hundred years ago, was much pleased with the activity and reputation for honesty of Demidof, and being anxious to encourage the working of mines, and also to set an example of emulation for others, made him and his heirs for ever a present of an extensive district, immediately surrounding his small patrimonial mine, with full liberty to work it. The enormous extent of ground thus obtained, proved a source of inexhaustible wealth to the good miner, for it was found to cover some of the richest veins of iron, of the finest quality, in Russia. Its produce soon enriched the industrious proprietor; and his son, having continued to work the mine, and to explore more ground, was enabled to employ the enormous capital thus justly acquired in purchasing additional estates, and among others that of Nijnétahilski, in which a gold mine was discovered soon after, that has

" *Iron Works.*—Here are meant all manufactories where raw iron is wrought into malleable iron and various instruments and utensils. Of these are bar-hammers, that are connected with every forge. A great majority of the iron here consists in thick bars, whereby the works reap infinite advantage, as many of them can be made at less expense, trouble, arts, money, and people. Indeed, several sorted irons are made, but proportionably in small quantities, quadrangular bar-iron, and thin wheel-iron or strakes. There are also, though not many, rollers and shears for cutting nail-iron.*

" *Steel Hammers.*—Though there has been long in Russia, at several works, what is called " uklad," or raw steel, or even, perhaps, refined steel, for the use of their own shops, made merely of old iron, yet not made, as has sometimes been said, of half raw iron and half bar-iron.

" For obtaining true steel, it has been advanced that they forge together the bar-iron with an equal weight of raw iron, without cooling the raw iron or remelting it; bend it together if it be straight, forge it again, and repeat this three or four times."

A company of Frenchmen, and others, attempted, some years ago, to make cemented steel of Siberian bar-iron. These works, however, came to nothing; but, seeing that every year great quantities of foreign steel were imported, a manufactory was established, in 1785, by sovereign authority, at Ekaterinburg, on the model of that at Steyermark, where, from raw iron alone, a strong condensed steel, like that of Steyer, is prepared, and where since, as the works have been enlarged, as much steel can be made as is wanted for the empire, though the ores of those parts have by no means the quality necessary for that purpose.

Anchor Forges.—There are, at several of the mine works,

yielded, on an average, forty-nine poods yearly, or 100,679*l.* sterling in pure gold."—*Granville's Travels.*

* A very curious article, produced by the Russian workmen, are the little bullets, which are made in the village Pavlovsk, on the Volga. They are no bigger than a pea, and cost, in Shahlenborg's time, only half a ruble per dozen; at present, one of them costs as much.—*Pallas.*

very large anchors made, both for the use of the navy and for exportation.

Flatting Mills, at which tin plates are made for home consumption.

Nail Manufactories.—Most of the nails for the inland trade are made by the smiths in some districts of the Volga, for which they generally use the slit-iron from Siberia. There is a manufactory of nails near Narva.

Wire Mills are not numerous, and do not make enough for home demand, therefore wire and wire-work are imported.

Needle Manufactories.—There is a needle fabric in the Pranskoi circle, and a needlemaker lives in Reval; nevertheless, several millions of needles are imported every year.

There is no manufactory for scythes in Russia. In three years were imported, at the ports of the Baltic alone, 2,118,033 scythes. If we add to this what come in through Poland and over the Euxine, the number will amount to greatly above a million per annum. In Moscowa scythes cost usually fifty to sixty copecs, but in Siberia they are not to be had for less than a ruble. At some of the mines attempts were made to make scythes and sickles; however, they turned out but badly, and, therefore, the business was dropped.

Manufactories of Fire Arms.—In the empire are four, all belonging to the crown. The oldest, and the greatest, is at Tula. It was put on its present establishment in 1717, and employs upwards of 4000 workmen.

The second is Sestrabek, forty versts from Petersburgh; the third is at Petrozavodsk, in the government of Olonetz; and the fourth in Orel. That at Sestrabek has upwards of 400 master workmen.

The works at Tula were, by supreme command, newly built in 1782, for which 388,000 rubles were allotted: it delivers every year arms for 15,000 men. Its yearly expenditure amounts to about 100,000 rubles, for which, besides the above, a considerable quantity of arms are made. The manufacturers receive for their own work 25,000 poods of crown iron. In 1797 the following tariff was published at St. Petersburgh:—

DUTIES UPON EXPORTATION.

		R.*	C.
Iron, old and broken	per berkovetch †	1	0
„ in bars of all sorts	„	0	40
„ in lumps, not wrought	„	0	80

DUTIES UPON IMPORTATION.

Steel, per cask of three poods	1	30
Needles, per 1,000	0	30
Wire for needles, per pood	0	12

Goods imported at St. Petersburgh in 1797, with their amount in rubles: —

Needles, 58,000,000	56,410 rubles.
Steel, 1,220 poods	10,143 „

Exports from all ports of the Russian empire, except those of the Caspian, in the year 1793: —

	Poods.	Value in Rubles.
Bar-iron	2,503,757	4,258,228
Sorted	491,575	901,464
Plate iron, kettles, and other cast-iron wares	37,917	44,433

Comparison of the amount of the exportation in 1768 with that of 1793, in rubles: —

	1768.	1793.	Increase of 1793.
Iron	1,443,000	5,159,000	3,716,000
Small iron ware	20,000	44,000	24,000

And in 1798 there was exported in British ships from St. Petersburgh: —

Iron	2,352,217 poods.
Old iron	24,860 „
Hoop iron	2,120 „

To such an extent had the trade in iron with Great Britain increased, that the government of Russia imagined that we could not carry on our manufactures without their assistance. They raised the price, by degrees, from 70 to 80 copecs per pood, which it was in 1770, up to 200 to 220 copecs for new

* The ruble may be estimated at 4*s.* during the greater part of the reign of the late empress.—*Tooke.* The present value is about 3*s.* 1*d.*

† A berkovetch contains ten poods.

sable, and 250 copecs for the best old sable. And, in 1794, the government established a loan bank, to accommodate the Russian iron-masters, by advancing them money on the security of their iron, to compel the English to give them such prices as they demanded.

In 1798 the proprietors of the iron mines succeeded in procuring a prohibition to the exportation of timber altogether, which they afterwards modified, with a view of benefiting themselves.* This measure was the means of raising the price of iron, in consequence of the additional freights the English were obliged to pay, because they could not get deals sufficient with which to load their ships. In 1790, in consequence of a fall in the price of wood, a new regulation was made, partly through the influence of the iron proprietors, who maintained that, if the English must have deals, they ought to be proportioned to the quantity of iron they took, which was, therefore, regulated at 284 standard dozen of white wood deals, for every 100 tons of iron.

By an ukase, in the spring of 1804, half that quantity of wood was allowed, in addition to the white wood deals, for the same quantity of iron. To these ill-advised measures may be added the following arbitrary conduct on the part of the Emperor Paul, who had in various instances displayed the capriciousness and irrationality of his character. He indulged a resentment against England on several accounts, of which the principal was the disappointment of his expectations of obtaining possession of Malta, which he fancied due to him as the grand master of the order. Particular attention had also been paid to him by the French Government, and he had become an avowed admirer of the character of the first consul. As he was very open in his declarations, he had caused to be inserted in the *Petersburgh Gazette*, of Sept. 10. 1800, as the motive for posting large bodies of troops on the coasts of the Baltic, that several political reasons induced the emperor to think that a rupture of the friendship between Russia and England might ensue; and he published in the same paper, in the end

* In the government of Perm alone, it is supposed that betwixt three and four hundred thousand tons of charcoal are consumed to smelt and work iron and copper.

of October, a declaration of his determination to revive the armed neutrality. Shortly after, he took the decisive step of laying an embargo on all the British ships in his ports, amounting to near 300, accompanied with the measure of taking out their masters and crews, and sending them into confinement in remote places of the interior. He also sequestered all British property on shore, and put seals on all warehouses containing English goods. He announced that the embargo would not be taken off till Malta should be given up to Russia, conformably, as he said, to the convention of December, 1798.

The emperor's actions had long denoted insanity, and, having become intolerable to his subjects, and dangerous to those about him, he was removed from his throne by the only mode practicable under a despotic monarchy; and, on the 22d March, 1801, it was announced that he was found dead in his bed. His son and successor, Alexander, immediately declared for the laws and political system of his august grandmother, Catherine the Second; and one of his first acts was to liberate and bring back from their places of confinement all the British mariners belonging to the sequestrated ships.

England, by these acts, was thrown on her own resources, and with the aid of improved machinery, and the great alterations which had taken place in the process of manufacture, was soon able to do altogether without the assistance of Russia, if we except the C.C.N.D. old sable iron, which is extensively used in the manufacture of steel.

We learn from Mr. Granville that, in 1828, there were throughout the whole extent of Russia, as well as in the Ural chain, nineteen foundries, forges, and mines belonging to the crown, yielding annually 1,301,000 poods of mineral, which, independently of a vast number of pieces of artillery manufactured out of it, produced 500,000 poods of pure iron, 12,000 poods in anchors, 9,000 poods in steel, and crucibles for smelting silver ore, and 32,000 small arms.

The establishments belonging to private families were 148 in number, yielding annually from 7,453,999 to 8,622,396 poods of mineral, out of which were made from 5,142,921 to

6,120,997 poods of iron, 23,379 to 70,244 poods of steel, and 234,873 scythes.

The duty which the crown received from this produce amounted to from 802,220 rubles 96½ copecs to 1,268,365 rubles 95¼ copecs on the mineral.

By a return furnished to the House of Commons, it appears that in 1830 the produce of the iron mines was as follows:—

Crown mines - - -	378,698 poods.
Private mines - - -	6,468,450 „

AVERAGE MAKE OF UNWROUGHT IRON.

Years.	Tons.
1831 to 1839 - - - - - - - - -	161,561
1840 — 1848 - - - - - - - - -	173,275
1849 — 1851 - - - - - - - - -	191,492

The exportation of iron from Russia has been upon the decline since the year 1784, when the whole export from Archangel and the Baltic was about 50,000 tons, of which Great Britain took above 40,000 tons; and in the year 1781 she took from St. Petersburgh alone 3,203,487 poods, which is about 50,000 tons. In the year 1804 Great Britain imported 868,420 poods, nearly 14,000 tons; and in 1805 only 5848 tons.

The average of bar-iron exported from Archangel and St. Petersburgh, from the year 1824 to the year 1838 inclusive, was 13,500 tons; from 1839 to 1841, 17,505 tons; from 1846 to 1848, 13,323 tons; principally to the United States of America; the quantity to Great Britain, averaging from the year 1843 to 1847, 2559 tons; in 1851, 3974 tons; and in 1852, 1791 tons.

Exports from Russian ports in the Caspian Sea: —

ASTRACHAN AND BAKU.

IRON.

Years.	Value.	Years.	Value.
1824 - -	£17,449	1828 - -	£23,967
1825 - -	15,978	1829 - -	38,162
1826 - -	7,107	1830 - -	40,251
1827 - -	10,555	1831 - -	15,253

Years.	Cwt.	Value.
1830 - - -	88,830 - -	£40,251
1831 - - -	44,869 - -	15,253

HARDWARE.

Year.	Value.	Year.	Value.
1830 - -	£7,063	1831 - -	£5,266

By caravans between Russia and Independent Tartary : —

IRON.

Years.	Cwt.	Value.
1830 - - -	9,226 - -	£4,211
1831 - - -	7,204 - -	3,163

HARDWARE.

Year	Value.	Year.	Value.
1830 - -	£12,469	1831 - -	£9,608

The trade with the Transcaucasian territories and in the Caspian Sea :—

Years.	Value.
1847 - - - -	£17,299
1848 - - - -	16,046

CHAP. X.

FRANCE.

By the law of the National Assembly of France (to which Belgium was then united), dated 28th July, 1791, mines were declared to be "at the disposition of the nation," in so far that they should not be allowed to be worked "without the permission of the nation, and subject to its inspection." Previously to that period mines had been treated as a part of the property of the crown, and had been the subject of various grants from time to time to individuals.

It appears, from the report of M. Regnauld (d'Eperey) to the National Assembly, on which the Law of 1791 was founded, that, during the earlier periods of the monarchy, specific grants from the crown were required before a mine could be worked by a private person. This strictness was subsequently relaxed, and from 1321 to 1548 the kings of France allowed any one who chose to work mines, on the condition only of paying to the crown a tenth of the produce, and indemnifying the proprietors of the surface for any damage. It seems that "abuses arose from this indefinite liberty," in order to remedy which successive monopolies were granted, from 1548 to 1601, to individuals, "of all the mines in the kingdom." From 1601 to 1744 the regulations fluctuated seven or eight times; absolute, or nearly absolute, liberty being at one time given to all proprietors of the surface; at another a strict monopoly of all the mines in the kingdom being granted to one person. In the year 1744 — and again, by a subsequent minister of the crown in 1765 — concessions of certain mines were made under certain terms to private persons, which concessions were in force at the

time of the discussion of the law of 1791. It resulted, from the conflicting course of regulation up to that period, from the rights, more or less perfect, acquired during those years by individuals, and from the opposition made during the discussion of the law, that the National Assembly forbore to insist, in as broad terms as some of its members desired, the rights of the state to the mineral property of the kingdom; and, accordingly, the rights of the proprietors of the soil were recognised and excepted in many important particulars: all quarries and mines reaching to only 100 feet in depth were reserved to them, and the preference of working all others found on their own land.

This law, having been found to work ill, was superseded by that of Napoleon, bearing date 21st April, 1810, which abridged still further the rights of the proprietors of the surface. Accordingly, the law of 1810 transfers to the government the absolute right of determining to what parties the permission to work mines shall be granted, whether proprietors of the surface or not, reserving only to such proprietors a certain amount of dues, and indemnity for damage done to the surface; and it creates, by the "Act of Concession," a personal property in the mine conceded.

The course of proceeding being thus entirely a matter between the government and the persons applying for leave to work a mine, it is open to the former to dictate the conditions prescribed to every one seeking and obtaining such permission. These conditions are embodied in the law of 1810, in an imperial decree by Napoleon, dated 3rd January, 1813, in the deed entered into by the persons obtaining the concession, and in other documents; in particular for Belgium, in the royal ordonnance of 11th August, 1841, on the police of mines in the province of Hainault.*

Ancient Gaul, comprehended between the Alps, the Rhine, the Pyrenees, and the ocean, contained within itself sufficient riches for the attraction of the industrious Phœnicians, whose trading occupations rendered them at a very early period

* "Report on Mining Inspection in France and Belgium," by Seymour Tremenheere, presented to both Houses of Parliament, 1847–8.

acquainted with the inhabitants of Gaul and Spain, to whom it is more than probable they communicated their methods of working mines and metals with a view to their own advantage, in the same manner as they instructed the early Britons afterwards. The warlike nations of Gaul appear to have been well armed, and their prodigious armies were well disciplined. Their early practice of mining had rendered the uses of metals familiar, and the army which had nearly sacked Rome under Brennus, about 370 B.C., and the host led by another Brennus into Greece, 278 B.C. to plunder the Temple of Apollo at Delphos, both mark advanced skill and organisation. Cicero mentions his opinion, that the Gauls were the most obstinate and formidable enemies of the Romans, and were so powerful, that, had they been able to find sustenance, they might have destroyed Rome, prior to their subjection by Julius Cæsar. We have just traced this outline, in order to confirm the fact of the progress of the early Gauls in the art of war, the sinews of which are metals, and especially iron, which abounds so largely, and the manufacture of which was well known amongst them. We find that the most ancient inhabitants of this country occupied themselves in the manufacture of this metal as a matter of the first necessity; this fact is attested by Rutilius, Strabo, and particularly by Julius Cæsar, in speaking of the vigorous resistance which the Berruyers made while he was engaged in the siege of Bourges. He says—"They took down our embankment by mines, the more scientifically, because they have great iron works, and every kind of mines known and in use." *

Thus, then, long before the conquest of Gaul, the Berruyers worked their iron mines; and proof of the immense extent of their works is found in the enormous heaps of cinders which are to be seen in various parts of the forests and open lands of the department.

These works were carried on with portable furnaces and forges, which were worked by manual labour or beasts of burden,—which cannot reasonably be doubted, because, where these cinders are found, there are no streams of water, nor

* Lib. vii. c. 21.

are there to be found any traces of water having ever flowed there.*

Such was the state of this branch of industry when the Romans, after having made the conquest of Gaul, applied their knowledge in mechanics to the construction of furnaces and forges worked by streams of water.

Towards the end of the last century the French Government took active measures to become acquainted with the state of the mines, and also to introduce any improvements which would facilitate the working of them. Scientific men were sent to the most celebrated mines of Europe, and a Royal College of Miners was established, where distinguished *savans* taught gratuitously all the sciences connected with the sinking of mines. The young men admitted to the lectures had before them a collection of minerals, comprising the mineralogical history of the kingdom; and, to join practical to theoretical knowledge, indispensable to the miner, the pupils in the summer season devoted their time to the most important workings — pursuing their labours under able instructors.

In furtherance of their object to obtain a knowledge of the mines which furnish the raw materials, and also of the forests, the wood of which is consumed in the manufacture, the government, in the year 1784, appointed the Baron de Dietrich to make a general survey, and report on the state of the mines and manufactures, and to estimate the extent of the forests relatively to the establishments which are consuming them, in order that government might check the increase of works in some places, or authorise the erection of new ones, as the state of the forests would allow, and the local interests might require.

The baron accordingly visited and reported on the whole extent of the Pyrenees, included in the districts of Pau and Auch, Alsace, and the duchies of Lorraine and Bar.

* That method was adopted in the department of the Cher, but not exclusively so, since there were also at the commencement of the last century portable forges in the canton of Henrichemont, and it is not many years since the bellows of the works of La Guerche were worked by oxen or horses, when the waters were too low for the purpose.—*M. de Barval.*

By his report it appears that, in the districts of Pau and Auch, they made, in thirty-eight forges, 75,800 quintals, of 100 lbs., of forged-iron. Alsace, 92,000 quintals of cast-iron, and 62,720 quintals of forged-iron. Lorraine and Bar, 204,750 quintals of cast-iron, and 145,150 quintals of forged-iron. Also in Franche Compté 40,100 quintals of cast-iron.

The memoir does not show how much of this cast-iron was used in the forges, nor what was employed in making castings, but it states that a considerable quantity was consumed in castings, and also that a portion of the metal was sent to the Duchy of Luxembourg.

At this time, encouragement was given by the government to the establishment of works for the use of coal instead of wood, which subject occupied considerable attention. The memoir of the Baron de Dietrich states, that the queen, in order to encourage those of her subjects who wished to form establishments for lessening the consumption of wood, gave them her patronage, and wished that a considerable capital should be advanced to the forges and royal foundries of Indre — and, to give confidence to the nation that the king had not agreed to the adoption of the new processes until he had been convinced of the immense advantages which might be derived from them, the queen interested herself directly in the prosecution of the new undertakings.

"Four furnaces, thirty-nine feet high, form at Mont Cenis the iron work, with coal free from sulphur; four reverberatory furnaces are erected there, capable of making 12,000 lbs'. weight at a single cast, and in a state to be refined with coke — an important discovery of the English, which has cost them twenty-five years' labour, and from which we shall reap the advantage as soon as they will.

"Five engines are actively employed at the foundry of Creusot; they serve, at the same time, to raise from the bosom of the earth the coals which are consumed — furnish blast to the furnaces — and, also, to work the immense forge-hammers. The absence of a stream of water, so often an obstacle to the erection of works in the best situations, will present no difficulties to such works as have recourse to these processes.

"Works constructed like those of Mont Cenis, upon the land which will supply them with coal, will answer the double object of saving the expense (often ruinous) of the carriage of coal, and checking the destruction of the forests.

"The briskness of coke, increased by the impetuosity and the volume of air given out by the bellows from the blast engine,* will increase to so great an extent the produce of one work, that the four furnaces of Mont Cenis will produce easily 10,000,000 to 11,000,000 lbs. of cast-iron per annum — a quantity that ten of our largest furnaces would hardly yield in working the same mines."

The memoir then calls on the works of Alsace and Lorraine to adopt the same methods, and states that the Comptroller-General intends to publish the particulars of the mechanism of the engines, in order to bring them the sooner into general use.

The annual produce of the 108 departments of the Republic had already reached, in 1801, to nearly 140,000 tons of cast-iron, resulting from the working of 550 blast furnaces of these 140,000 tons, about 112,000 tons were the produce of 450 furnaces belonging to France, reduced to her present boundaries.

The produce of wrought-iron in the 108 departments of the Republic, at that time, was 94,000 tons, of which about 79,000 were furnished by the eighty-six departments now belonging to France.

One single blast furnace (that of Creusot) was worked with coke.

M. de Bonnard (an engineer of mines) published, in 1809, by order of council, a description of the English process of making iron; another engineer of mines (M. de Gallois), after having passed several months in England, in studying their methods in the most minute detail, established near St. Etienne (in the same department where, some years later,

* The largest bellows of our forges give 500 cubic feet of air per minute; the eight bellows, required for four furnaces, will give 2000 cubic feet; the three belonging to the engines furnish 9000 cubic feet in the same time. — *Baron de Dietrich.*

a member of the same body, M. Beaumier, constructed the first iron railway) the first blast furnace in France, wherein the minerals were treated in the same manner as the English, and the third in which coke was employed.* M. de Gallois, notwithstanding the extent of his knowledge, both theoretic and practical, could not overcome the difficulties to be encountered by those who wish to introduce new processes into districts where they have hitherto been unknown; the blast furnace, constructed under his direction, had not at first that success which he had expected, and his premature death is attributed to the grief and trouble which this enterprise occasioned him.

The manufacture of wrought-iron with pit-coal proceeded step by step with the making of cast-iron with coke. In 1820 Messrs. Boiguer and Dufand, at Fourchambault, and M. de Vandel, at Hayange, had built extensive works, which have served as models for all which have since been erected. These examples were not fruitless; an increase was soon seen in the number of iron works wherein pit-coal was employed, either partially or in the whole of their operations.

In 1818 the total consumption of iron in France did not exceed 122,000 tons annually, of which 114,000 were produced by the blast furnaces—5000 were old castings from the magazines—and 3000 were imported.

In 1824 the production had increased to 164,000 tons—the importation to about 7000; the consumption may be taken at 175,000.

	1818.	1824.
Production - -	114,000 tons.	164,000 tons.
Importation -	3,000 „	7,000 „
Consumption -	122,000 „	175,000 „

Referring to the statement already made of the production of 1801 in the departments now actually French, a statement extracted from one of the best statistical works of that period, it is evident that the annual production of cast-iron from 1801 to 1818 had not materially increased.

* The first blast furnace in France, worked with pit-coal, was that of Creusot; that of Etienne is the second—it was only established in 1818.

It appears, also, from some approximate data, that the quantity of cast-iron consumed in the foundries increased nearly in the same proportion with the total quantity of cast-iron consumed. It was in 1818 and 1824 nearly a sixth part of the total quantity. The proportion of castings made at the blast furnaces bore nearly the same ratio to their produce of iron, being almost constantly one-sixth.*

Total quantity of bar-iron used in the years—

	1818.	1824.
Consumption - -	86,000 tons.	118,000 tons.
Made in France † -	76,000 „	112,000 „
Imported - -	10,000 „	6,000 „

Thus, the production of bar-iron in 1818 was nearly the same as in 1801, or rather it was a trifle less; within ten years the consumption was nearly doubled, the production actually so, and the importation was reduced one-half.

The iron imported into France was principally from Sweden and Russia.

The importation in the years—

	1822.	1823.	1824.	1825.
Swedish iron in tons, about -	1,900	2,400	3,900	5,400
Russian iron in tons, about -	100	140	330	540

We have already observed, that the first forges on the English plan were established in 1820. In 1823 there were eleven in work, and four building. In 1826 there were only four blast furnaces using coke in full work, but there were thirty-one forges, or wrought-iron works.

In 1818 only a very small quantity of cast-iron was made with coke, and no wrought-iron was prepared with pit-coal. In 1824 the produce of cast-iron with coke was about 3000 tons, but of wrought-iron manufactured with pit-coal, 4400 tons were brought into the market.

* It is estimated that the quantities of iron made into castings in 1818 and 1824 may be stated at 20,000 and 28,000 tons, and the proportion made at the blast furnaces into castings, either at the first or second fusions, may be taken at 17,000 and 22,000 tons.

† From 9000 to 10,000 tons of these quantities of bar-iron have been made in the southern departments, by immediate reduction from the iron ore—a process commonly called the Catalonian method.

In 1828 the production of cast-iron was more than 200,000 tons, the importation about 8000, and the consumption about 213,000.

Bar-iron.—Quantity made in France, 152,000 tons; imported, 6000 tons; consumption, 158,000 tons.

Quantity of iron made into castings, 37,000; tons and the proportion made at the blast furnaces, 32,000 tons.

In 1828 the number of blast furnaces had increased to fourteen, and that of forges on the English plan to forty; 17,000 tons of cast-iron were smelted with coke, and 48,000 tons of bars made with pit-coal. Thus, the manufacture of cast-iron with coke chiefly developed itself from 1824 to 1828, whilst that of wrought-iron with pit-coal had already considerably extended itself in 1824.

These 17,000 tons of cast-iron made with coke do not amount to a tenth of the whole produce; and the 48,000 tons of bars made with pit-coal form nearly a third of the total manufacture of wrought-iron.

This disproportion between the respective quantities of cast and wrought-iron, as compared with the total produce, arises from the number of situations where it is found advantageous to make the cast-iron with wood-charcoal, and to refine it with pit-coal.

M. Auguste Perdonnet, in his report made to the society "Du Bulletin Universel des Sciences et de l'Industrie," read at the sitting of the society on the 24th April, 1831, as to "what improvement has the art of making iron received in France during late years."

"I will say but few words as to the improvement which the art of making iron has received. The attention of the French iron-masters has of late years been principally directed to the perfect naturalisation of the English methods in this country, and to the advantages which might arise from combining together, the process of fabrication with wood-charcoal, and those with pit-coal. They have, above all, applied themselves to economise fuel, the cost of which forms a very great part of their expenses.

"It is not many years since the working of our charcoal

blast furnaces, being altogether left to the routine management of workmen only, was in a very backward state. But competition has succeeded much better in leading our iron-masters into the way of improvement than all the advice of ingenious persons; and it suffices to compare the number of charcoal blast furnaces, and their total produce in 1801 and 1828, to be convinced of the progress that has been made in their manner of constructing and working them.

" In 1801 it required 450 charcoal blast furnaces, of which 420 at least were in work, to produce 112,000 tons of cast-iron. In 1828 only 379 furnaces produced 184,000 tons; thus, in the time elapsed between 1801 and 1828, the mean produce of a charcoal blast furnace has nearly doubled. At the same time, we are obliged, with regret, to acknowledge that all our charcoal iron works have not followed the progress of improvement. We yet find at a great number of them water-wheels, wretchedly constructed, and blowing machines more miserable.

" The reason why blast furnaces with coke have been so difficult to forward in France is, that our materials not being the same as the English, we have been obliged to make a great number of very expensive experiments to learn even now how to use them. But these furnaces have at last begun to give satisfactory results, at least in a technical sense.

" We should, however, very far deceive ourselves if we were to form an opinion of the prosperity of our manufactures by their increased production. If we penetrate into these establishments, and examine them closely, we soon are convinced that this immense development of the means of manufacturing has not always been a source of benefit to the iron-masters. Many of their works are in a state of real distress — enormous capitals have been swallowed up — each one in his turn has attempted their management — they have had in succession at their head clever theorists, expert practicians, Frenchmen, Englishmen, and Germans — the custom-house duties have been increased for their protection, and still they are in general far from being in a state of prosperity.

"The causes are numerous — the too great distance of some of these works from the raw material — also the bad quality of the mineral — or the inability, perhaps, of some of the persons to whom the management has been intrusted — and, lastly, the blow given to commerce by late events; all these circumstances have, doubtless, contributed to arrest the progress of the iron manufacture in France. But part of these circumstances have, at the present time, ceased; the cost of labour has much decreased, and the experiments are finished. The want of means of transit and communication is more grievously felt by our iron manufacturers than by any others, for some of our iron works are threatened with ruin from this cause, if it be not speedily remedied.

"Thus, at Fourchambault, at St. Etienne, Hayange, and other iron works where the cast-iron is made with coke, the expense of carriage alone amounts to one-third, if it be not nearer one-half, of the total cost of manufacture, so that the ton of metal is charged with 60, 70, or 80 francs for the cost of transport only.*

"We have an inexhaustible supply of minerals, excellent in quality, most of them equally rich with the English. We have pit-coals in abundance, many kinds yielding coke, well suited for the blast furnaces, and costing us less at the mine than theirs, except at a very few places. Limestone and fire-clay are to be had at the quarry equally cheap, and labour costs less in France than in England. But nowhere, as I believe, are all these raw materials found together exactly at the same point, as is the case in Wales, where the same mine supplies coal, ironstone, fire-clay, and limestone — or, if in some localities, as at Allais and at Aubin, they are near to

* The cost of transport upon an ordinary road may be estimated, on the average, to be 1f. 50c. for 100 kilogrammes carried one league (about four kilometres). At Chatillon, where they refine with coals the metal made with charcoal, the coal of Rive de Gier, their best for the purpose, costs 56f. per ton, whilst it sells for only 20f. at the pit. At Hayange, the coal of Sarrebuck, sold for 5f. per ton, costs 30f. At Fourchambault the coal of St. Etienne, only 5f. at the mine, comes to 30f. at the iron works. At Audincourt they use the coal of Rouchamps, which, bad as it is in quality, costs 25f. per ton on the place, and 38f. 50c. at the furnace, but it is only used in the chaferies to reheat the blooms before drawing them into bars.

each other, there are no canals or railways, or even good roads, to take the produce away."

There are at this time in France twelve distinct localities or districts, in which the making of iron is prosecuted, which are distinguished in the official reports *:—

1. Group of the north-east.
2. " of the north-west.
3. " of the Vosges.
4. " of the Jura.
5. " of Champagne and Burgundy.
6. " of the Centre.
7. " of the Indre and La Vendée.
8. " of the coalfields of the south.
9. " of Perigord.
10. " of the Alps.
11. " of the Landes.
12. " of the Pyrenees.

The actual and relative importance of these groups may be seen from the following particulars, having reference to the working of 1836:—

Group.	Number of Iron Works.	Number of Workmen.	Quantity of Fuel in Tons and Steres.				Quantity of Products.			Value of Products in English Money.
			Wood-Charcoal.	Coke.	Coal.	Wood.	Cast-iron.	Bar-iron.	Steel.	
			Tons.	Tons.	Tons.	Steres.	Tons.	Tons.	Tons.	£
1	94	2,233	90,844	3,530	8,230	33,583	46,233	30,450	162	530,599
2	59	1,771	54,051	- -	2,964	- -	23,755	11,182	-	210,238
3	7	388	- -	7,315	24,830	- -	2,226	9,189	-	147,500
4	148	2,090	126,754	- -	910	- -	54,737	28,900	581	652,030
5	152	2,807	139,602	- -	40,947	- -	81,499	42,309	-	691,528
6	124	2,133	71,098	14,094	35,798	- -	36,993	27,029	766	501,362
7	21	499	17,564	- -	- -	- -	5,824	2,870	-	61,085
8	15	1,243	- -	87,444	115,038	- -	28,440	27,276	-	377,158
9	115	1,175	39,120	- -	3,399	- -	14,893	9,064	96	173,646
10	39	174	6,614	- -	251	- -	2,021	282	1,120	6,916
11	21	410	17,466	- -	32	478	7,118	3,674	-	62,535
12	99	815	30,742	- -	- -	- -	- -	9,466	-	171,140
	894	15,738	593,855	112,383	232,399	34,061	303,739	201,691	2,725	3,585,737

* "A Statistical View of the Recent Progress and Present Amount of Mining Industry in France," by G. R. Porter, Esq.

The figures given in the foregoing table do not present in all their importance the extent of this branch of industry in France. The number of workmen employed for the production of pig-iron (*fonte*), malleable iron (*gros fer*), and steel, which alone are there included, does not much exceed one-third of the number engaged in all the various processes of the iron manufacture; and the total value of the material produced, instead of being, as in the above statement, 3,585,739*l.*, amounted in 1836, according to the returns of the inspectors, to 4,975,424*l.* The following abstract contains all that it appears desirable to offer on this occasion, and presents under five principal divisions the total number of workmen engaged in the manufacture, with the value created by them in each of those divisions: —

	No. of Workmen.	Value created.
1. Extraction and preparation of the ore -	17,557	£500,632
2. Production of pig-iron (*fonte*) - - -	6,776	1,969,132
3. Production of malleable iron (*gros fer*) -	8,678	1,506,247
4. Founding, drawing, rolling, &c. - -	8,615	812,486
5. Converting, moulding, casting, &c., steel -	2,149	186,927
Total - -	43,775	£4,975,424

Rather more than 40 per cent. of the value here stated is made up of the cost of the fuel used in the various processes, viz.: —

Wood-charcoal - - - -	£1,643,826
Wood - - - - - - -	13,040
Coke - - - - - - -	96,972
Coal - - - - - - -	285,235
Peat - - - - - - -	694
	£2,039,767

This sum is divided among the different processes in the following proportions:—

	£	Dec. Propor.
1. Roasting the ore - - - - - -	1,782	0·087
2. Smelting - - - - - - -	1,132,039	55·500
3. Refining, puddling furnaces, &c., &c. -	737,888	36·175
4. Casting, drawing, rolling, &c. - -	121,556	5·959
5. Moulding, casting, &c., steel - -	46,502	2·279
Total	£2,039,767	100·000

It will be seen that four-fifths in value of the fuel is composed of wood. Coke was not used in the iron works of France until 1821, and at the present time is employed almost exclusively for processes subsequent to smelting the ore. The proportionate value of different kinds of fuel consumed in the various processes in each year, from 1833 to 1836, has been:—

	1833.	1834.	1835.	1836.
Wood-charcoal - -	0·838	0·818	0·864	0·806
Coal - - - -	0·098	0·129	0·098	0·140
Coke - - - -	0·062	0·050	0·037	0·048
Wood - - - -	0·002	0·003	0·001	0·006
	1·000	1·000	1·000	1·000

The average prices of the different kinds of fuel in 1836, as stated in the report, were:—

Wood charcoal - - -	54*s.*	10*d.*	per ton.
Coal - - - - -	18	5	„
Coke - - - - -	20	3	„
Wood - - - - -	2	10	per stere.

The increased proportion of wood, observable in the working of 1836, is caused by the substitution in part, in some works, of wood dried by heat or partially carbonised. By the introduction of a porportion of dry wood in place of charcoal, a diminution in the cost of fuel has been attained; but against this advantage must be placed the smaller produce obtained from the furnace in a given time, as well as a diminution of metal from a given quantity of ore. Where wood-charcoal alone is used for smelting, it requires eighteen metrical quintals for the production of thirteen metrical quintals of iron. Where coke and coal are used in the proportion of ten of the former to nine of the latter, it requires about three quintals of fuel to produce one quintal of iron. In some cases, coke is used with charcoal in the proportion of one quintal of coke to two quintals of charcoal, and the produce has been eight quintals of iron for ten quintals of fuel. In the first case (where wood charcoal is used), the cost of the fuel has been 9·92 francs per metrical quintal of iron, or

4*l.* 0*s.* 6*d.* per English ton. The cost, when coke and coal are used, is stated to be 4·45 francs per quintal, or 36*s.* 1½*d.* per ton; and in the third case, where coke and charcoal are mixed, the cost is said to be 7·60 francs per quintal, or 3*l.* 1*s.* 8*d.* per ton. The value assigned to the produce is:—

	Francs.		£	s.	d.	
In the first case - -	20·99	per quintal, equal to	8	10	4	per ton.
In the second case -	11·13	„ „	4	10	4	„
In the third case -	20·32	„ „	8	4	11	„

The mixture of coke and charcoal would, upon the whole, appear to be the most profitable in its result. Deducting from the value of the metal the sum expended for fuel, there would remain, when charcoal alone is used, 4*l.* 9*s.* 10*d.* per ton; when coal and coke are used, 2*l.* 14*s.* 2½*d.* per ton; and when coke and charcoal are used, 5*l.* 3*s.* 3*d.* per ton. These calculations are, of course, wholly inapplicable to the circumstances in which the manufacture is placed in this country, from the actual and relative cheapness of our mineral fuel. The use of the hot-blast has been adopted in several of the furnaces in France. At first it was found that the iron thus obtained was not so well adapted for making bar-iron as that for the smelting of which cold air had been used; but some modifications, which are not particularised in the reports, have been introduced into the process; and this disadvantage, it is said, has been remedied. No account is given of the quantity of iron made in France earlier than 1824; but from that year the account is regularly stated in the reports from which the following abstract (in English tons) has been computed:—

Years.	Pig-iron.	Malleable iron.
1824	194,636	139,564
1825	195,588	141,396
1826	202,756	143,336
1827	213,175	146,621
1828	217,604	149,117
1829	213,868	151,319
1830	222,965	146,242
1831	221,423	138,942
1832	221,660	141,336
1833	232,559	149,982
1834	265,028	174,507
1835	290,378	206,396
1836	303,739	201,691

As in the case of coals, the importations of foreign iron into France have kept pace with the increase in the native production. The custom-house accounts of that country are detailed with great minuteness, but it is not necessary here to particularise the quantities of each description of foreign iron used in France. The value of the iron imported for use in the year 1815 was 87,556*l.*; 1825, 150,690*l.*; 1835, 231,208*l.*; 1836, 252,702*l.*

Having traced the manufacture of iron, we will now refer to the measures of the French government to protect this branch of their trade. During the war, and the interruption to foreign commerce which it occasioned, several branches of industry grew up in France, or were considerably extended, for the successful prosecution of which she is not, under ordinary circumstances, any wise fitted. Of these iron may be specified as one. The extraordinary demand for warlike instruments, occasioned by the war, gave a powerful stimulus to this trade; and when peace was restored those engaged in it were necessarily involved in considerable difficulties. But these, howsoever severe they might be in the first instance, were not of a sort that could have continued for any considerable period. Had no adventitious principle been interposed, the manufacturers would gradually have changed their business, and instead of producing cannon and muskets, would have learned to produce those improved agricultural and manufacturing instruments that were either unknown in France, or obtained only from the foreigner: but matters were not allowed thus to adjust themselves. The iron masters represented to government that they were in a state of extreme distress, and that this distress was occasioned by the importation of foreign iron, and not by the transition from war to peace. The government lent a favourable ear to these representations, and, in consequence, the duty on foreign iron, which had continued at 2f. 20c. the 100 kilogrammes,* from 1790, was raised, in 1814, to 15f., being an increase of nearly seven times its previous amount. This, however, was not found sufficient to secure to the iron-masters that mono-

* A kilogramme is equal to 2 lbs. 2 oz. avoirdupois.

poly which they were naturally anxious to obtain, and, in 1821, they again represented that this enormous increase of duty was insufficient for their protection, and, on the 3rd of November, in the same year, an ordinance was published relative to the importation into France of foreign iron manufactured by rolling.

The preamble of the ordinance refers to the law which authorises the government to change the regulations of the tariff of the customs, and to present the alteration to the Chambers in the form of a law project. Then, after stating that it is necessary to protect the manufactured iron of France against the competition of foreign iron, manufactured by rolling (the price of which is greatly inferior to hammered iron), it is ordered that, from fifteen days after the publication of the ordinance, all such iron, when imported, shall be placed in *entrepôt*, and shall afterwards pay the duty which may be fixed by law when taken out of the warehouse for consumption.

In the course of the financial discussions, some members of the opposition endeavoured to recommend a liberal system of commercial policy, and to imitate, in this respect, the example which England was now setting to the world. But propositions of this kind met with no favour from any party, and with vehement condemnation from the ministers. "Let the system of prohibition," said M. de St. Cricq, Director General of the Customs, "be for an instant abolished, then Odessa inundates us with her grain — England with her steel, with her hardware, her cottons, and with almost all the objects of daily use and convenience, in which she possesses the same superiority over us which we have over her in the productions of our soil and the objects of our industry." — "Let us suppose these relations established between other countries, and observe the change in your situation. There is not a person who, understanding the interests of our trade, would consent to enter on the career of freedom."

The ex-minister, M. Laine, quoted England as an authority for severe commercial restrictions, and maintained that her late departures from that system were not examples to be

imitated by other countries. "England," he said, "had first adopted the system of exclusion, and it was not, therefore, very remarkable, that, finding it enforced against her, she should be inclined to change her practice. She had derived from prohibition all the advantages that she could hope for—she had accumulated immense capitals — her industry had been so much developed, that she was obliged to seek for a large outlet, and, perhaps, on this account, she had come to the point of saying—' Now we will receive you, only receive us.' "

The duty was again raised from 15f. to 25f. the 100 kilogrammes.

The duty is of two kinds: that of 15f. per 100 kilogrammes, which was imposed in 1814, and which is levied on iron fabricated with charcoal and the hammer—that is to say, on the iron of the North, of Spain, and even of the Netherlands; that of 25f., imposed in 1822, and which is chargeable on the iron fabricated with coal and the rollers—in other words, almost exclusively on the English iron.

"The French iron was, in 1814, at 60f. the 100 kilogrammes, but, as the most accurate calculation had made it clear that the iron-masters could not afford to sell the common iron below 50f. to get any reasonable profit, it was understood that, below that rate, foreign iron should not be admitted to compete with ours in our own markets. The northern irons, the only ones whose rivalry was at that time taken into consideration, were generally sold in our staples at the medium price of 36f.—a tax of 15f. and (with the tenth) of 16f. 50c. was added to it, in order that they might not be offered to purchasers below 52f. or 53f. But a few years afterwards a rapid depreciation, not hitherto warranted by better conditions in the means of production, having taken place in the prices at home, signalised the *invasion* of the English irons, which, being fabricated with coal and the rollers, were sold in our maritime *entrepôts* at the moderate price of 21f.; and it was only in 1822, after two years of recrimination and complaints, that it was deemed necessary, both to protect our own charcoal fabrication and to encou-

rage the incipient efforts of France to fabricate with coal, to apply to this particular species of fabrication a tax of 25f. and (with the tenth) of 27f. 50c., which, making the cost 48f. or 49f., a rate very near that which had been fixed for the iron of the North, was considered less as a real aggravation than a rational, and in some degree a necessary, application of the principle of the tariff of 1814." *

These exaggerated duties completely answered the purpose for which they were imposed. In 1817 the importation of bar-iron alone was 18,789,014 kilogrammes, 17,824 tons, and continued to be a prosperous trade to the importers, in spite of the duty of 15f., till 1822. In 1821 the importation was 13,843,724 kilogrammes, 13,133 tons. The increase of the duty on English iron was immediately succeeded by the following decrease of imports: —

In 1822 the importation was only			4,800	tons.
1823	,,	,,	4,200	,,
1828	,,	,,	5,500	,,

In 1828, the government, urged on by the complaints of the public against these high duties, appointed a commission to inquire into the state of the iron trade, and M. de St. Cricq, whose opinion on free trade has already been given, was chairman of the commission.

It had been the intention of the French legislature to favour the iron-masters, into whose hands the difference of price created by the tax was intended to fall. These expectations were, at first, fulfilled; the iron-masters made large profits, and doubled their production in the first six or seven years after the peace. What was the consequence? Their success drew fresh capital into the trade. "Of the 93,850,000f. of capital sunk," says the *Enquête*, "about 47,000,000f. belong to the newly-erected establishments." The manufacture was pushed forward with accelerated speed. Certain materials are necessary in the manufacture, the most indispensable of which is fuel, which, in France, consists chiefly of wood, or rather charcoal. If the *prix de revient*, or cost-

* Enquête sur les Fers, 1829.

price of iron at the furnace be examined by the data furnished to the commission, it will be found that the ore, inclusive of the mining expenses, forms only 11 per cent., whilst the fuel, exclusive of the cutting and carriage, amounts to 39 per cent. The increased production of iron gives rise to a greater consumption of wood — and what follows? The price of iron rises, but the price of wood rises simultaneously, with this peculiar disadvantage, that being of slow growth*, the market cannot be supplied with an increasing quantity of wood, as with an ordinary commodity, so that a general rise in price continues of necessity for a long period. An iron-master at Chatillon-sur-Seine, in the Côte d'Or, says, that in 1822, he bought the *banne* of charcoal (fifty cubic feet) at 16f., for which he now pays 23f. 50c. In the Meuse the *banne* cost 18f. 3c. in 1822; it now costs 37f. 50c. At Fourchambault, in the Nivernais, the iron-master bought the *corde* of wood (sixty-four cubic feet), in 1821, at 3f. 50c., which now costs from 5f. to 6f. In the Meuse it was 3f. the *corde* of forty-nine cubic feet in 1820; now it is nine. In 1818 the produce of the year's fall of the government woods brought into the Treasury 20,181,000f.; in 1828 the same quantity produced 29,309,000f., being a difference of nearly 50 per cent. in the price.

The prodigious effect of the iron manufacture on the price of wood becomes more credible, when we read the following words of M. Le Baron Pasquier, the reporter of the commission:—"The total value of combustible wood used every year in the forges, may be reckoned at 30,000,000f. (1,200,000*l.*), which is about a fourth of the forest revenue."

In spite of the tariff of 1822, the trade was not so profit-

* The total extent of the forests of France is 6,521,470 hectares (nearly equal to two acres); this total, after deducting one-fifteenth part, which consists of large timber, and one-fourth of wood consumed in public and private establishments, is reduced to 5,610,833 hectares of wood, susceptible of being cut in twenty years upon an average—which allows to be cut annually 280,541 hectares. According to the evidence of various statisticians, we may calculate the annual cutting of wood in France amounts to 9,804,928 cords, of eighty cubic feet, or two and three-quarters stivers.[1]—*M. Heron de Villefosse*, 1827.

[1] A measure of wood equal to a cubic metre, or a little better than a cubic yard.

able as it was before that period. One of the witnesses, an extensive iron-master of Champagne, says:—"We made some profit when we sold at 450f. (the 1040 kilogrammes), and we are now losers in selling at 500f.; the cause of which is, that, in 1819, the *banne* of charcoal cost 18f. 3c., while it now costs 37f. 50c."

The proprietors of wood (the landowners) received the profits.

In 1818 the manufacture of bar-iron amounted to 800,000 quintals, that of cast-iron to 1,400,000 quintals—all smelted with charcoal. The increased price of wood having led to the use of cheaper fuel, a vast number of the forges established by the new comers were erected on the English plan. We find that of 1,521,881 quintals, forged in 1828, 476,116, or nearly one-third, were made with coal. The difference in the cost of production is surprising. One of the witnesses says, that to produce 1040 kilogrammes, of ordinary iron smelted with charcoal, he is obliged to use five *bannes* and a quarter of charcoal, which, at 41f. 50c. per *banne*, amounts to 207f. 50c., whilst, to produce 1000 kilogrammes with coke, he has only to employ 1700 kilogrammes of coal, at 49f. 50c. per 1000 kilogrammes, which amount only to 84f. 15c. The proportion of the cost of coal to charcoal is nearly as nine to twenty. The difference in the expense of labour and carriage is not less striking. M. Pasquier says that labour and carriage form at least, on the average, 43 per cent. of the *prix de revient* of the wood-made iron, whilst in that of the coke-made iron they do not reach higher than 29 per cent.

The reporter avers that "the average price of iron smelted with charcoal is 49f. 12c., and the average price smelted with coal is 38f. 50c." The result of the *Enquête* was, that the commission proposed that the existing tariff on iron shall be maintained for five years longer, at the expiration of which period the present import duty on foreign iron shall be reduced by one-fifth.

The following is an abstract of the speech delivered by the French Minister of Commerce, in the Chamber of Deputies,

on the 21st May, 1829, on the proposed alterations in the French tariff*:—

"The king, gentlemen, has commanded us to lay before you a law project, containing certain modifications in the tariff of our custom duties, the principal provisions of which are the fruit of the researches and deliberation of a commission appointed to that effect. In recommending the appointment of this commission, gentlemen, I did not abandon my personal conviction. My opinion, which has been frequently expressed to you, remains unchanged, namely, that it was not expedient that everything should be prohibited, nor everything permitted. Unrestricted freedom for trade at home, and all the freedom compatible with manifest necessities for foreign trade, are the conditions of our industry of every kind. If a protecting system were to yield abruptly to a system of unrestricted freedom in transactions between all nations, foreign labour would come into the French markets, and usurp the place of national labour. A prudently devised protecting system is the necessary and permanent regulator of the divers conditions under which nations exercise their industry. Almost every branch of French industry would be in peril the moment it had to stand in competition in the market of France, without protection against foreign produce and manufactures. Even if, as some persons argue, the branches of industry destroyed could be replaced by other branches more profitable, this would occasion a social perturbation, the consequences of which could not be anticipated without alarm. It is not that France would cease to produce corn, to cultivate the olive-tree, flax and hemp, and to breed cattle, horses, and sheep, if the corn of the Crimea and Poland, the hemp of the north, the flax of Belgium, the oil of the Levant and Italy, the oxen of Germany and the Netherlands, the wool of Spain and Moravia, and the horses of Friesland and Mecklenburgh, were admitted duty free; but the price of all these

* Duchatet's (Secretary of State for the Department of Commerce) report to the king, 1834. (J. Bourwingis' Reply, p. 22.) "Cast-iron could not formerly be imported in pigs under 400 kilogrammes. This *minimum* is reduced to 25 kilogrammes."—8th July, 1834.

objects would become discouraging, and, perhaps, insupportable, to the French grower and breeder. Still less would the iron works, the cotton, the linen, and woollen cloth, and the hardware manufactories of France, be able to stand against the unchecked invasion of English cotton goods, Flemish linen and woollen drapery, the iron and hardware of Sweden, England, and Germany. Even the flourishing manufactories of Lyons would receive a shock by the free importation of India silks, which, in 1820, at the outcry of the manufacturers of Lyons, were prohibited—instead of paying a duty of 20 per cent. By what other branches of trade, gentlemen, could those which I have enumerated be replaced? I admit that we should supply a greater quantity of wine to other nations; but I know no other article in which we have an advantage in point of price. Assuredly, our wine-growers would not purchase their prosperity by the ruin of so many other interests? and, besides, is it certain that this ruin would not reduce the consumption of wine at home in a proportion equal to or greater than we might obtain abroad? An advantage might at first accrue to wine-growers by a greater sale abroad; but they would soon feel the painful effects of an inevitable re-action. Let them look at wealthy England, of whose market they are so envious; in that country the consumption of wine is scarcely 30,000 pipes, whilst a moderate tax on beer yields 200,000,000f. to the revenue. In countries where the vine is indigenous, a few of the best growths of France find a market; but in countries to which nature has refused the vine, other beverage is made use of, and little room is left for a consumption which the wealthy alone can obtain. The inference to be drawn from hence is, not that our present tariff is the best that can be, and that no figure can be altered; but that our productions and manufactures cannot dispense with a tariff. The question is, what extent of protection shall be given to each of the branches of our industry? Here is the controversy, and the field is sufficiently ample. The controversy arising between interests ever distinct and often opposed—the necessities of different branches of industry being variable in their nature, and a need

existing of protecting the interest of the consumer — attentive inquiries and prudent revisions became necessary from time to time. Objections have been started against the appointment of a commission, but when was it ever known that an examination of complaints was injurious to the interests of the complainants? Vehement complaints have been made upon the duty of foreign iron, and upon the utility and possibility of maintaining the actual colonial *regime*. The government could not suppose that there were no points connected with these subjects of which it might not be ignorant, and hence these questions were submitted to the commission. The general opinion of the commission, in which every doctrine had organs, and every interest defenders, is, that the commercial system is an obliged consequence of the political separation of nations; that in this system, prudently applied, is the guarantee of public and private property; that all unnecessary prohibitions are an evil, but that certain prohibitions may be indispensable; that the protection resulting from duties is, therefore, habitually preferable to that resulting from formal prohibitions; that there exist rights wherever interests have been created under the protection of the laws; and that in France a reasonable system of protection should be adhered to. This opinion of the commission coincides with my own, and if it adds nothing to my conviction, it inspires me with confidence in supporting it. You now know, gentlemen, upon what principles, and under the influence of what idea, the commission proceeded to the solution of the two weighty questions to which I have already referred. The problem that remained to be solved was, what degree of protection should be granted? It relates to iron and sugar— two articles of immense consumption in France. The commission began with the question on iron, and then proceeded to that on sugar. In 1814, at which period France knew no competition in iron, except that of the north, a uniform duty existed of 15f. per 100 kilogrammes. In 1822 the duty was augmented to 25f. Nothing but wood being at that period employed in working iron, the effect of the augmentation of the duty was to increase the price of iron and that of wood.

Coal, however, soon began to be made use of instead of wood, and the law of 1822 was justified in the protection of the capital of the new system of working with coal. The consumption of iron, however, became much greater than before, and hence the price of both iron and wood rose, because coal was as yet employed but in few iron works. The duty upon iron had been fixed at a time when the price of that article in England was only 7*l.* 10*s.* or 8*l.* per ton; but the price suddenly rose to 15*l.* and 16*l.* If it had kept at the former price, English iron would have come to the relief of the consumer, and supplied the demand, to which the quantity produced in France was not equal, in consequence of the great augmentation in the consumption; and the price of wood would, at the same time, have kept within its due limits. In France, as in England, things have now returned to their natural order, except that the consumption has diminished. England now offers iron at 7*l.* per ton; and in France the production, which, in 1814, was computed at 800,000 or 900,000 *quintaux metriques**, has gradually increased to 1,500,000, of which nearly 500,000 quintals are wrought by means of coal. There is reason to believe that this production exceeds the consumption — the calculation being made upon the last three years. The inquiry of the commission shows that the price has already fallen 20 per cent. The use of coal is extending rapidly, and iron works are establishing in every direction, so that it has become a question whether, in a few years, the market will not be overstocked. Convinced that the production of iron in France is equal to the consumption, the commission are of opinion that foreign competition should not be invited, and consequently, that the present rate of duty should be maintained. In examining the question, they have come to the conclusion that the reduction of the duty on iron would not lead to a greater exportation of wine to the countries that produce iron. The wine duties in England have been recently reduced, and yet it has had but little influence on the quantity of wine imported there from France. But, although the commission consider that no reduction could be

* 10·1464 *quintaux metriques* make one English ton.

at present made without danger in the duty on iron, they are of opinion that it would be advantageous to fix a period when a reduction could be made in proportion to the ameliorations that might reasonably be expected. They, therefore, propose that the present duty should be continued for five years; that at the expiration of five years the duty should be reduced one-fifth; and that after five years more, namely, in 1840, the Government and the Chambers should again take the question into consideration. The government approves this principle, but proposes that, in 1835, the duty should be reduced only one-tenth, and in 1838 another tenth—leaving, according to the recommendation of the commission, the duty upon its present footing till 1835, and the question for reconsideration in 1840. Relative to cast-iron, which, when brought by sea, pays a duty of 9f. per 100 kilogrammes, several founders are of opinion that the manufacture of France for machines and ornamental mouldings is far inferior to that of England. The commission, therefore, proposes to reduce the duty of 9f. upon cast-iron for the above purposes; the government proposes to reduce it to 7f. The government and the commission coincide in opinion that, with respect to cast-iron for the above purposes, the restriction which requires it to be of a certain form, and of a weight not less than 400 kilogrammes, should be done away.

From a report laid before the Chamber of Peers early in the year 1841, by M. Cunin Gridaire, the Minister of Commerce, it appears that, since the French Government reduced the protecting duties on foreign produce, the trade of the country had increased considerably with regard to iron; he states that, in the year 1828, France possessed 393 furnaces, producing 2,000,000 metrical quintals of cast-iron, and 1295 furnaces for refining,—manufacturing annually 1,500,000 metrical quintals of iron. At present, France possesses 475 furnaces, which produce annually 3,477,000 metrical quintals of cast metal, worth 63,000,000f., and 1500 furnaces for refining, which produce 2,241,000 quintals of iron, worth nearly 93,000,000f.

Average make of pig-iron:—

1837 to 1841 - - - -	306,345 tons.
1842 — 1846 - - - -	386,856 „

On the 22nd November, 1853, the tariff on iron was fixed as follows:—

IRON PER 100 KILOGRAMMES.

	F.	C.
Pig-iron, weighing 15 kilogrammes or more, by sea.—In French vessels	5	0
In foreign vessels - - - - - - - - - - -	5	50
By land, from Blanc Misseron inclusively, to Montgenevre exclusively, from the adjacent countries - - - - - - -	4	0
From all other places - - - - - - - - - -	5	0
In bars (*etire*), without regard to the mode of fabrication, in French vessels and by land, flat bars of 458 millimetres and more, the length multiplied by the thickness - - - - - - -	12	0
218 millimetres inclusive, to 458 millimetres exclusive - - -	14	0
Less than 213 millimetres, same thickness, ditto - - - -	16	0
In square bars of 22 millimetres and more on each side - -	12	0
15 millimetres inclusive, to 22 millimetres exclusive, ditto - -	14	0
Less than 15 millimetres, ditto - - - - - - - -	16	0
In round bars of 15 millimetres and more in diameter - - -	14	0
Less than 15 millimetres, ditto - - - - - - - -	16	0
By foreign vessels, the above duties and one-tenth more.		
In rails.—Same duties as those on bar-iron, according to their dimensions.		
In plates, or *lamine noir-tôle.*—In French vessels - - - - -	25	0
In foreign vessels and by land - - - - - - - -	27	50
Steel in bars, cast or wrought.—In French vessels - - - -	40	0
In foreign vessels and by land - - - - - - - -	44	0

ART. 2.—From the 1st January, 1855, the duty on iron shall be levied according to the following table:—

Raw pigs, weighing 15 kilogrammes and more, per 100 kilogrammes, by sea.—In French vessels - - - - - - - -	4	0
In foreign vessels - - - - - - - - - - -	4	40
By land - - - - - - - - - - - - - -	4	0
Bars, without regard to the mode of fabrication, in French vessels, and by land, in flat bars of 458 millimetres and more, the length multiplied by the thickness - - - - - - - - - -	10	0
213 millimetres inclusively, to 458 millimetres exclusively - -	12	0
Less than 213 millimetres, ditto - - - - - - - -	14	0
In square bars of 22 millimetres and more on each side - -	10	0
15 millimetres inclusively, to 22 millimetres exclusively - -	12	0
Less than 15 millimetres, ditto - - - - - - - -	14	0
In round bars of 15 millimetres and more in diameter - - -	12	0
Less than 15 millimetres, ditto - - - - - - - -	14	0
The same by foreign vessels—the above duties and one-tenth more.		
Rails.—The same duties as on bar-iron, according to their dimensions.		
Plates.—In French vessels - - - - - - - - -	20	0
In foreign vessels and by land - - - - - - - -	22	0
Steel in bars, cast or wrought.—In French vessels - - - -	30	0
In foreign vessels and by land - - - - - - - -	33	0

Art. 3.—The laws, decrees, and ordinances which are not opposed to the present decree remain in full force.

Art. 4.—Our Minister of Agriculture, of Commerce, and Public Works, and our Minister of Finance, in their respective departments, are intrusted with the execution of this decree.

Done at the Palace of Fontainebleau, on the 22nd of November, 1853.

Napoleon.

Countersigned by the Minister Secretary of State for the Department of Agriculture, Commerce, and Public Works, P. Magne.

As English ships employed in the trade between France and England have been since 1826 assimilated to national ships, it will only be necessary, as regards iron, to place the former duties in comparison with those now to be paid on importation by French vessels, English vessels being in the same category:—

	Former Duties, per ton.			Duties, per ton, till Jan. 1. 1855.			After Jan. 1. 1855.		
	£	s.	d.	£	s.	d.	£	s.	d.
Pig-iron	2	16	8	2	4	0	1	15	4
Iron in bars according to the dimensions	from 6	12	0	5	5	10	4	8	0
	to 8	4	10	to 7	0	10	to 6	3	4
Iron-plates	17	12	0	11	0	0	8	16	0
Steel in bars:—Cast	26	8	0	17	12	0	13	4	0
Wrought	52	16	0						

Rails, the same as iron bars, according to dimensions.

The following notice was subsequently published:—

"The Right Hon. the Lords of the Committee of Privy Council for Trade and Plantations have received, through the Secretary of State for Foreign Affairs, a copy of a French Imperial Decree, from Her Majesty's Ambassador at Paris, regulating the restitution of the duty on unwrought iron used in the manufacture of steam engines, of which the following is a copy:—

"'Art. 1.—A partir de loi Juin 1854, la restitution du droit d'entrée sur les fontes brutes étrangères, employées à la fabrication des machines à feu de 100 chevaux ou plus, dont l'installation à bord des navires destinés à la navigation maritime aura été dûment constatée par les agents des douanes, s'effectuera à raison de 300 kilogrammes de fonte par cheval de force, y compris le déchet de fabrication, et de 4f. 80c. par chaque 100 kilogrammes.

"'Art. 2.—Sont maintenues en vigueur les dispositions de l'ordonnance du 30 Mai, 1839, qui ne sont pas abrogées par l'Art. du présent décret.'"—*Times*, 8th April, 1854.

In 1854 there were 4111 kilometres of Railway open.

CHAP. XI.

UNITED STATES OF AMERICA.

During the war of the Revolution the commerce of the United States was interrupted, not only with Great Britain, but in a great measure with the rest of the world. The Americans were then compelled to depend almost entirely upon themselves for supplies, not only of arms and munitions of war, but of those articles of common consumption which they had previously imported from Great Britain and elsewhere. Those articles which their soil would not produce, or which they were unable to make, they were obliged to obtain at great risk and expense from other countries, or to be content without them. Encouragement was given to all the necessary manufactures, and the zeal, ingenuity, and industry of the people supplied the place of a foreign market.

At the close of the war, when the independence of the States was acknowledged, their commercial, as well as their political, situation was new, and they had many difficulties to encounter. During a contest of seven years their commerce was annihilated — shipping nearly destroyed, and public credit impaired — a general constitution for the American States was framed. They entered into a perpetual union, or confederation, with each other, for their mutual defence and advantage. They agreed that delegates should be appointed by each State, to meet in Congress on the first Monday of every year; that no State should be represented by fewer delegates than two, or by more than seven; that each colony should have a single vote; and that the laws and decisions of the Supreme Assembly should be obligatory on all the provinces under its jurisdiction. Each State, however, was to be governed wholly by

its own legislature, and with the enactments of that legislature the Congress had no right to interfere. It was not difficult to perceive that this constitution had not within itself sufficient energy to produce and ensure a vigorous administration of affairs. The Congress had no authority over individuals; it had no power to force even the States to a compliance with its injunctions; and in case of any quarrel it could not prevent them from making war upon each other. Difficulties occurred, and distresses were multiplied on every side. The army, though disbanded, had received only four months' pay. The debts contracted by the Congress, as well as by many individual States, had not been discharged, and, therefore, were daily increasing; and the government possessing no revenue, could give no effectual value to its paper currency. Taxes were imposed by some of the provincial legislatures; but as they were far beyond the means of the inhabitants, and levied with the utmost rigour, they occasioned very general discontent; and though it had been fondly expected that, after the termination of the war, the commerce of the United States would revive, it was still embarrassed and languid. The vast influx of goods, also, drained the country of money, and some of the importing States levied duties for their own advantage.

In this situation all became sensible of the insufficiency of the general government, and of the necessity of vesting Congress with the power of regulating trade and commerce, and bringing into operation the energies and resources of the country for the general benefit. In consequence of a proposition from the State of Virginia, commissioners from that State, and from the States of Pennsylvania, New York, New Jersey, and Delaware, met at Annapolis, in Maryland, in September, 1786, to take into consideration the "trade and commerce of the United States; to consider how far a uniform system, in their commercial intercourse and regulations, might be necessary to their common interest and permanent harmony, and to report to the several States; such an act, relative to this great object, as, when unanimously ratified by them, would enable the United States, in Congress assembled, effectually to provide for the same."

This report and address was sent to Congress, and to the several executives of States not represented at Annapolis; and, in consequence of the recommendation contained in the address, by a resolution of Congress, of 21st February, 1787, a general convention of the States, with the exception of Rhode Island, assembled at Philadelphia, and, after choosing General Washington for their president, they proceeded to the arduous duty which they had undertaken to perform:—"To take into consideration the situation of the United States, to devise such further provision as shall to them appear necessary to render the constitution of the federal government adequate to the exigencies of the Union," &c.

On the 17th September following, a new constitution was agreed upon, and by it the general government, among other important matters, were vested with power to "regulate commerce, and to levy duties, imposts," &c.

On the 4th day of March, 1789, the first Congress, elected according to the new institute, met at New York, having previously, by the unanimous voice of the provinces, elected General Washington to the chief magistracy of the American nation.

No sooner had this new form of government, with the father of his country at its head, begun to operate, than a new vigour seemed to be diffused through all the provinces. Trade and commerce revived—public and private credit was restored—a new spring was given to agriculture and manufactures—and new security afforded to the various pursuits of honest industry. The finances were arranged—the public debt was gradually reduced—a national bank, with a capital of 10,000,000 dollars, was established—the arrears due to the army were paid—a small permanent force was organised—the administration of justice was decisive, but equitable; and, though some disturbances arose on account of the taxes, or the way in which they were collected, yet the peace and prosperity of the colonies were, happily, secured.

From the establishment of the government the progress of national, as well as individual, wealth kept pace with the increase of population; and, until the commencement of com-

mercial restrictions, in December, 1807, and the declaration of war against Great Britain, in 1812, no nation, it is believed, had ever increased so rapidly in wealth as the United States. The well-known orders of the British Council, and the Berlin and Milan decrees, almost destroyed American commerce. Great Britain declared France to be in a state of blockade, and the ports of Holland, with the whole Continent, from the Elbe to the Weser, as well as the ports of Italy and Spain, were included in this declaration. The British islands were declared to be in a similar state of blockade, and American vessels, bound to their coasts, were denationalised, confiscated, or burned on the high seas. England insisted that the United States should renounce all trade with the colonies of the enemy, from which they were excluded during peace, and prevent their citizens from trading with France, or with any powers adopting or acting under the French decrees; and all American vessels bound to any port on the Continent, from which the British flag was excluded, were seized and condemned. Those sailing to or from France, with American or French produce, were declared liable to seizure if they did not put into some British port, and then pay for permission to sail for the port of original destination. Under these declarations more than 900 American merchant-vessels were captured by the English in time of peace. On the other hand, France declared that the British islands, being in a state of blockade, all commerce with them was prohibited, and every American vessel bound to England or her colonies, or that paid a tax, or suffered a visit, was condemned as British property.

By the Bayonne decree, all vessels sailing under American colours were considered as British. American vessels destined for Sweden, Russia, and Denmark, were captured by Danish cruisers, and condemned in their courts, notwithstanding the most unquestionable evidence of their neutrality, and their destination to countries in amity with France, the ports of which had been declared open to American vessels. In the ports of Naples American vessels were also sequestered.

American property, to the amount of 30,000,000 of dollars,

was placed at the discretion of the Admiralty Courts of England, and a still greater amount was submitted to the French Council of Prizes, or Council of State. In this situation an Act of Congress was passed, by which no vessel was allowed either to leave or enter the American ports. This embargo was a necessary measure, to put an end to the seizure and confiscation of property,—to recall the ships and seamen, and prevent them from being employed abroad in the licensed trade.

The distress felt in America, in consequence of these prohibitions, was very great; insomuch, that she made an attempt to regain, by an amicable settlement with France or England, the commercial freedom which she once enjoyed. To France she proposed to re-establish her commerce on such a footing, that Britain should not share in the benefit to be derived from it; and she hinted, that if the peaceful communication between the two countries should be interrupted by England, that then she would join in the war against her. To Britain she proposed, if she would agree to rescind her orders in council, to repeal her embargo, and also to shut her ports against France, provided France persisted in her hostile decrees.

France declared that the decrees of Berlin and Milan were repealed, but the American commerce in France was impeded in various ways. The introduction of colonial articles was prohibited, and vessels arriving with the productions of the United States were subject to exorbitant duties, tedious examinations, and forced exportations. Great Britain, therefore, doubted the fact of the repeal of those decrees, and refused to revoke or modify her orders in council, and the act of commercial non-intercourse was enforced against her.

The temper of the government in the United States, at the commencement of the year 1812, rendered it evident that nothing could prevent extremities with Great Britain, except the repeal, by the latter, of its orders in council, or a dread in the former of entering into a very hazardous contest, with a prospect of much domestic discontent. The spring passed in the discussion of various measures of preparation by the

Congress, in which the war party displayed a manifest preponderance.

An act for an embargo on all the shipping of the United States, for the term of ninety days from its date, passed the Congress in the beginning of April; the purpose of which was to expedite the fitting out of the American ships of war, and to prevent any more pledges from remaining in the power of an enemy on the commencement of hostilities. The result of the discussions in Congress was an act passed on the 18th June, declaring the actual existence of war between the United States and Great Britain.

With the view of putting an end to the war, Russia, in August, 1813, had proffered her mediation, which was accepted by the United States, but declined by England. This power, however, afterwards proposed to treat directly with the American government; and, in consequence of this, the American plenipotentiaries, then at St. Petersburgh, repaired first to Gottenburgh, and afterwards to Ghent. Here, after some months of negotiation, a treaty was signed on the 24th December, 1814. In this treaty the parties mutually agreed that certain disputed boundaries should be settled by a commission, that peace should be made with the Indian tribes, and that the treaty should become binding four months after its ratification. On the original ground of dispute between the parties, nothing is said; the cessation of hostilities in Europe having changed the circumstances out of which the war arose, neither party felt itself under the necessity of discussing the claims for which it took up arms. The treaty, after being submitted to Congress, was ratified by the President, on the 17th of February, 1815.

We have thus briefly sketched the principal events connected with the declaration of war against Great Britain, as they were the immediate cause of the investment of capital, hitherto employed in commerce, in iron works and other manufactures. To protect the capital thus invested, heavy duties were fixed on the foreign manufactures, so that they amounted almost to a prohibition of the English bar-iron.

The restrictive commercial regulations of Europe, and the late war with England, gave a great stimulus to American manufactures, and their progress during the course of a few years was almost incredible. Many new branches were introduced, and those which had been already established were carried to a much greater extent. The principal cause of the neglect of manufactures, formerly, was the great profits afforded by agriculture, with the high price of labour. All the materials for manufactures are found in America. Fuel is inexhaustible; the ores of the most useful metals are in great abundance. In the year 1809, the Secretary of the Treasury unfolded the resources of the country, in relation to the raw material, and proposed various means for the promotion of manufactures, — protecting and prohibitory duties, drawbacks, premiums, bounties, encouragement to new inventions, arrangements for facilitating pecuniary remittances, &c.

The immense capital which had been employed in commerce, previously to the restrictions, was transferred to manufactures, and workshops, mills, and machinery for the fabrication of various commodities, were erected as if by enchantment. Foreign artists and tradesmen were encouraged to settle in the country. The implements, tools, and even the furniture of emigrant mechanics, were made free of duty. In Pennsylvania such persons were admitted as freeholders on the day of their arrival, provided they declared their intention of becoming citizens within the time prescribed by law. A knowledge of machinery, and processes for the saving of labour, were communicated, through the daily journals, to all descriptions of people. Mineralogy became an object of attention, and every district was ransacked for useful minerals.

In 1810, M. Gallatin, the Secretary of the Treasury of the United States, presented to Congress a report on the manufactures, in which, amongst many other branches, iron, and the manufactures of iron, are mentioned as being firmly established — supplying, in several instances, the greater, and, in all, a considerable portion of the consumption of the United States.

" The furnaces, forges, and bloomeries, of the United States amount to 530, of which the State of New York furnishes

sixty-nine. The annual value of iron and its manufactures is estimated at 12,000,000 or 15,000,000 of dollars. The average value of imported metal, in bar-iron and steel, at 4,000,000 dollars. The Franconia Iron Works, in New Hampshire, established in 1810, employ a capital of 100,000 dollars. The Vergennes Iron Works, in Vermont, promise to be very important. The price of bar-iron at this establishment is 140 dollars per ton, the ore three dollars, charcoal four dollars and a half per 100 bushels: 19,000 muskets are annually made at the two public armories of Springfield and Harper's Ferry. There is now a considerable surplus of small arms."

Some of the ores of iron are found in every State in the Union; and, about the period of M. Gallatin's report, mines of this metal were worked in New Hampshire, Vermont, Rhode Island, New York*, Connecticut, New Jersey, Pennsylvania, Virginia, and North Carolina.

According to the "Statistical Annals of the United States," by Adam Seybert, founded on official documents, the manu-

* Fulton's first steamboat was launched at New York the 3rd October 1807. There is a most interesting account of Fulton's experiments, and the introduction of steam navigation, in Baines's History of Liverpool, Chap. 17. Paley, speaking of our discoveries, or rather our projects, which turn out to be imitations of nature, says: "Some years ago, a plan was suggested of producing propulsion by reaction in this way: by the force of a steam-engine, a stream of water was to be shot out of the stern of a boat, the impulse of which stream upon the water in the river was to push the boat itself forward; it is, in truth, the principle by which skyrockets ascend in the air. Of the use or practicability of the plan, I am not speaking; nor is it my concern to praise its ingenuity; but it is certainly a contrivance. Now, if naturalists are to be believed, it is exactly the device which nature has made use of for the motion of some species of aquatic insects. The larva of the *dragon-fly*, according to Adams, swims by ejecting water from its tail; is driven forward by the reaction of water in the pool, upon the current issuing in a direction backward from its body."—*Nat. Theo.*

In a work entitled "Spiritalia seu Pneumatica," it is recorded that Hero of Alexandria constructed a machine 120 years B. C., which was worked by the mechanical force of steam, or the vapour of water. A hollow globe or ball was placed upon pivots, upon which it was made to revolve. Steam was communicated to the globe through a tube from the boiler. This steam filled the globe, and also the hollow arms which were fixed thereon, like the spokes of a wheel; a lateral orifice at the side end of each arm allowed the steam to escape in a jet, and the pressure with which the steam escaped caused the arms and the globe with the axis to rotate in the opposite direction. By the rotation of the globe and axis, a pulley fixed on the axis was capable of communicating motion by

facture of iron in the year 1810 was as follows:—153 furnaces, making 53,908 tons of iron; 330 forges, making 24,541 tons of bar-iron; 316 trip hammers; 34 rolling and slitting mills, which required 6500 tons of iron; 410 nailiries, in which 15,727,914 lbs. of nails had been made.* Manufacture of iron, value 14,364,526 dollars.

A commercial treaty between Great Britain and the United States was signed on the 3rd of July, 1815, to remain in force during four years, according to which each country was to enjoy reciprocal freedom of commerce. No higher duties to be imposed than those which extend to all other nations, in relation to articles imported and exported; and the vessels which carry them to be subject to the same duties and entitled to the same bounties.

Duties payable by law on iron imported into the United States of America, commencing on the 30th June, 1816:—

Iron bars and bolts, excepting iron manufactured by rolling	45c. per cwt.
Iron bars and bolts, when manufactured by rolling, and on anchors - - - - - - - - - - -	1 dol. 50c. ,,
Iron, cast, and all manufactures of which iron is the material of chief value - - - - - - -	20 per cent. *ad val.*

In the year 1818 an alteration was made in the tariff of the United States; and, again, in 1824, to come into operation on the 1st July of that year; and, in the year 1828, a still further alteration was made, particularly affecting British iron — it commenced on the 1st September.†

The following statement shows the rate of duty at the three periods: —

	1818. Dol.	cts.		1824. Dol.	cts.		1828. Dols.	cts.	
Iron, in bars or bolts, rolled	1	50	per cwt.	1	50	per cwt.	37	0	per ton.
In bars or bolts, not manufactured in whole or in part by rolling - -	0	75	,,	0	90	,,	0	1	per lb.
Pig-iron - - - -	0	50	,,	0	50	,,	0	62½	,, cwt.

means of a belt to any machinery attached. This is an application of the *principle* mentioned by Paley, and is identical with that of the rotatory engine.

* Mr. Perkins, of Newbury Port, invented a machine for cutting nails, by means of which 200,000 may be cut in a day.

† Previous to the settlement of the tariff of 1828, a committee was appointed by Congress to examine into and take evidence respecting the state of the home manufacturers.

The settlement of the tariff of 1828, increasing an already high rate of protecting duties, gave great dissatisfaction to many of the States, and petitions were presented against it. In the subsequent pages, in speaking of the operation of the tariff, it must be borne in mind that the arguments apply equally to the manufactures of cotton and wool as they do to iron, but, of course, keeping strictly to the subject-matter of this work, they are here, as much as possible, confined to the manufacture of iron.

On the 5th January, 1830, Mr. Mallary, from the committee of manufactures, to which had been referred that part of the President's message which related to domestic manufactures, reported to the House of Representatives against the expediency of altering the existing tariff. The report stated that, in the opinion of the committee, the tariff had not had a fair trial, and that the fear of an alteration in the tariff had had the effect of preventing competition in those manufactures for the benefit of which it was laid.

"The committee give it as their decided opinion that it is inexpedient to make any change in the existing laws, 'intended for the aid and protection of domestic industry.'"

Early in the following month the committee of ways and means reported to the House "A Bill to reduce and modify the Duties upon certain Imported Articles."

"That from and after the 30th day of June, 1830, the following duties shall be levied, in lieu of those now imposed by law, on the following, amongst other articles, viz.:—

"On iron in bars and bolts, whether manufactured by hammering or rolling, ninety cents per 112 lbs.—provided that all iron in slabs, blooms, and loops, and other form less finished than iron in bars and bolts, pay duty accordingly.

"On iron in pigs fifty cents per 112 lbs."

The tariff men of every description, in the House of Representatives, joined in refusing all consideration to this bill—the votes being 107 against consideration to 79 in favour of it. This method of meeting a measure, introduced by a standing committee, on the recommendation, too, of the President,

subject to the consideration of Congress, and putting it down without permitting argument or amendment, was without parallel in American legislation.

On the 8th February, 1830, Mr. Cambreleng, the chairman of the committee on commerce and navigation, submitted to the House of Representatives his celebrated report: —

" In 1807 the outrages of the two great belligerent powers made it necessary to commence a series of irregular restrictions on trade, which led to the war of 1812, and terminated finally with that contest in 1815. Previous to these political restrictions, from 1789 to 1807, our country presented a spectacle of prosperity which had never been surpassed by any nation in any age. We had been suddenly emancipated from a colonial condition — we had united the energies and resources of the States — we had not then learned to intermeddle with private employments — we had no heavy taxes to encourage smuggling, diminish consumption, and repress industry — we had no stimulants but profit and enterprise — no guides but intelligence and judgment. We had, it is true, discriminations, minute and manifold, but, happily for the country, our imposts were moderate, our speculations harmless, and our trade was free. The succeeding eight years of restrictions and war checked the natural and rapid march of our industry, and drove us into employments new and unsuited to our age and condition. The peace of 1815 naturally restored us to our old occupations; and the sudden reaction of the tide of commerce swept away a large portion of capital which had been prematurely invested. Peace had not only returned, but the world had every assurance of its long continuance. The bloody wars which preceded the fall of Napoleon—the termination of his ambitious career—the revolutions of governments, and the critical condition of thrones, left Europe and her sovereigns in no disposition to embark speedily in new wars. We had before us the prospect of a long and general peace, and our policy should have been regulated accordingly. Our revenue laws should have been restored gradually, but decisively, to their condition previous to the war. Our policy, unfortunately, took another direction. The tariff of 1816 laid

the foundation of all our subsequent errors, and we have now been engaged for fifteen years in an unprofitable experiment, to effect what embargo, non-importation, non-intercourse, and war, failed to accomplish. We have attempted, by the mere force of Congressional decrees, to resist the natural and salutary tendency of our industry to commercial and agricultural pursuits. We have been steadily sacrificing the commerce, navigation, and capital of New England, merely to bring forward new competitors in manufacturing, to embarrass our old and skilful artisans, and to ruin themselves. We have, from session to session, kept trade in such agitation and uncertainty, that the value of property could never be ascertained till the adjournment of Congress—and this we have called encouraging and protecting our industry. We have wasted millions of our ancient profits of commerce in a visionary experiment to increase our national wealth. In a legislative attempt to make ourselves more completely independent of foreign nations, we have most effectually undermined the foundation of that naval power which can alone protect our country from foreign aggression.

"Your committee are as unwilling to agitate this question as they are little disposed to disturb the value of our national property. But when our commercial policy for the last fifteen years is candidly reviewed, they feel persuaded that the House will come to the conclusion, that, however harsh it may be to reform the policy of a nation, its permanent welfare, its honour and its safety may sometimes render it necessary to avoid the calamities which may result from an obstinate perseverance in bad measures. The regulations of our commerce and revenue now existing, not only put in jeopardy our national honour and safety, and the interests of agriculture and navigation, but they will be found, on examination, to be of the most unfriendly character to the largest portion of our manufactures. Whatever may have been the honest intention of those who framed our laws, they can have no other tendency than to increase our taxes, diminish consumption, destroy trade, and, however extraordinary it may seem, to draw premiums from American industry to encourage British

manufactures, and to perpetuate their ascendency even in our own markets. In making a last attempt to arrest the progress of measures so destructive to our national prosperity, we shall not allow ourselves to be intimidated by the rapid succession of our acts since the war; 'and, however willing they might be to leave the pliability of industry to accommodate itself, even to the worst of laws, it is impossible to view this question in any other light than as an unsettled one.' The late President of the United States, in his last message to Congress, most truly said, that 'our tariff was, in its details, not acceptable to any portion of the Union, not even to the interest which it was specially intended to subserve.' Our present chief magistrate expressly 'invites our attention to the existing tariff, believing that some of its provisions require modification,' and he solicits 'our particular attention' to the agricultural interest. With the approaching redemption of our public debt, he justly anticipates that 'our population will be relieved from a considerable portion of its present burthens.' The committee, therefore, indulge the hope, that the political calm now existing will be wisely employed in devising and adjusting, in a spirit of mutual concession, some general plan which may relieve our industry from all unnecessary impositions, save our manufactures from capricious legislation and party vicissitudes, arrest the growth of unlawful trade, and give a fresh impulse to our commerce and navigation; and, above all, that we may, with patriotism, unite in our efforts to restore that good feeling which should always be cherished between the different sections of our Union.

"Our present tariff is, certainly, national in one respect—it is injurious to every interest and to every section of the country. Our manufactures, commerce, and agriculture may still slowly advance—for the energies of a young country may resist the repressing tendency of the worst of laws; but what would be the celerity of their march were we to reduce our duties on raw materials—our taxes on navigation, and our heavy burthens on agriculture? It would be some consolation to us if the taxes we have imposed upon ourselves had any tendency to give permanent encouragement to our

own manufactures; but, unfortunately, the provisions of our tariff are so singularly and ingeniously contrived, that the only result of our taxation must be to perpetuate the ascendancy, even in our own markets, of the manufactures of Great Britain.

"We have imposed an enormous duty on the fine wools of England, Saxony, and Spain, while the British manufacturer, besides having his supplies uniformly cheaper, pays on all foreign wool only from a halfpenny to a penny per pound. We have deprived our hardware manufacturers of all chance of competition with their British rivals, by charging so high a duty on their raw materials; that, in many instances, the mere duty on the latter actually amounts to more than the entire cost of the foreign manufacture. Our manufacturers of cordage, also, are about to be driven from our markets under the operation of our own laws. Our tariff is nothing but a tissue of such absurdities. By no rule of calculation can we ever expect that our manufactures can be permanently as cheap as foreign fabrics, while we persist in imposing enormous duties on raw materials, or higher imposts on the material than on the manufacture. Our existing revenue laws tend, inevitably, to perpetuate the manufacturing ascendancy of Great Britain*.

* "COMPARATIVE STATEMENT OF DUTIES.

	Great Britain. Dols. cts.	United States. Dols. cts.	
Iron in bars, per ton -	6 66	22 40	per ton, and 37 dols. if rolled. This is a British manufacture.
" pigs, " - -	2 22	12 50	

"Our manufacturers of hardware generally, and our blacksmiths and iron founders, are in a condition most discouraging. They, of necessity, consume sheet, hoop, bolt, rod, and bar-rolled iron, as raw materials. The Birmingham manufacturer is supplied with them at 30 dols. to 50 dols. per ton. Our duties vary from 37 dols. per ton to $3\frac{1}{2}$ cents per pound, or 78 dols. 40 cts. per ton, or from $123\frac{1}{3}$ to $156\frac{4}{5}$ per cent. *ad valorem.* In other words, the effect of our own law is to give a premium to the hardware manufacturers, blacksmiths, &c., of Great Britain, equal, on an average, to 55 dols. 70 cts. on every ton of iron manufactured in that country for the use of the United States. The actual prices on these raw materials, in Great Britain, are 30 dols. to 50 dols., and in the

"Banishing the manufacture of cordage from our country is not the only injury we have inflicted on our navigation; we are actually destroying the trade of ship-building. The statement below* exhibits the comparative taxes on British and American navigation. The incidental effect of our own policy

United States, 75 dols. to 180 dols. per ton. The duty on fifteen pounds of sheet and band-iron, for fender-plates, is 52½ cents; on twenty pounds of sheet-iron, for grate-pans, 70 cents; on the manufactured article, 18¾ cents; on 100 pounds of sheet-iron, for stove-pipes, 3 dols. 50 cts.; on the stove pipe manufactured, 68 cents. The duty on hardware generally is 25 per cent., while the duties on the various kinds of iron used in manufacturing average about 140 per cent., *ad valorem*, giving more than 100 per cent. premium to the British manufacturer.

"The American iron-masters, &c., may see how effectually they are destroying our home market for their productions, by perpetuating duties, which are actually nothing but so many premiums, drawn from the consumption of the United States, to encourage the manufacturers of Great Britain, &c. Our existing tariff, which is proclaimed to be for the encouragement of our manufacturers, is replete with such palpable absurdities. If we had all the capital and labour of Great Britain, our manufacturers would inevitably decline under the gradual influence of such laws."—*Report.*

* "COMPARATIVE ADVANTAGES OF BRITISH AND AMERICAN NAVIGATION IN THE CONSTRUCTION AND FITTING OUT OF SHIPS.

Duties levied in each country on the materials consumed in building and rigging a ship of 500 tons:—

BRITISH DUTY.

	Dols.	cts.
If not 'copper fastened,' 20 tons of iron, say 7 tons Russian and Swedish, at 6 dols. 66 cts. - - - - - - - - -	46	66
13 tons English, no duty.		
20,160 lbs. chain cables, say 9 tons, at the duty on iron, 6 dols. 66 cts.	60	0
4,600 lbs. anchors.		
62 pieces heavy duck, 2,356 yards.		
20 „ light duck 760 „		
3,116 „ at 7½*d.* - - - - - -	432	67
15 tons cordage, requiring 12 tons hemp, at 4*s.* 8*d.* per cwt., say 20 dols. 74 cts. per ton - - - - - - - - - -	248	88
British tax on a ship of 500 tons - - -	788	21

is to give a premium of 1655 dols. 89 cts. on every ship of 500 tons, built and fitted out in Great Britain."

Mr. Cambreleng followed up his report by bringing in a bill to amend the Navigation Laws of the United States, which was read twice: —

"Be it enacted, by the Senate and House of Representatives of the United States of America, in Congress assembled, that whenever the President of the United States shall receive satisfactory information of the existence of any law or decree of any foreign government, authorising the importation of the produce and manufactures of the United States into such foreign country, and all its possessions, at a rate of duty not exceeding 30 per cent. on the actual value thereof, and at such times as the produce and manufacture of that country may not be admitted into the United States on reciprocal terms; thereupon the President of the United States shall issue his proclamation, declaring that he has received such evidence, and, from and after twelve months from the date of such proclamation, it shall be, and is hereby declared to be, lawful to import into the United States the produce and manufactures of such country, and all its possessions, at a

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AMERICAN DUTY.

	Dols.	cts.
If not 'copper fastened,' 20 tons of iron, say 7 tons Russian and Swedish iron, at 22 dols. 40 cts.	156	80
13 tons English, at 37 dols.	481	0
20,160 lbs. chain cables, at 3 cents.	604	80
4,600 lbs. anchors, at 2 cents.	92	0
3,116 yards duck, at 10 cents	311	60
12 tons hemp, at 60 dols.	720	0
American tax on a ship of 500 tons	2,366	20
American duty on 500 tons	2,366	20
British duty on 500 tons	788	21
	1,577	99
Add for increase on 3,116 yards of duck, at 2·1-2 cents.	77	90
Premium on every British ship of 500 tons	1,655	89

rate of duty not exceeding 30 per cent. on the actual cost or value thereof," &c.

The effect of such an enactment would have been a virtual repeal of the tariff law, and the trade of Great Britain would have been the chief gainer by the change. The blacksmiths, and other manufacturers of iron, residing in Philadelphia, presented a petition to the House, praying that the duty on certain descriptions of iron might be so modified as to afford to them an adequate protection in their business: this petition was referred to the committee on manufactures, and ordered to be printed; an answer was drawn up by the committee to this petition. The tariff party were, however, too strong for the Chamber of Commerce, and also for the memorialists, and the act introduced by Mr. Cambreleng was not allowed to pass.

The rejection of this measure gave great dissatisfaction to the Southern States, and Mr. Blair, a member for South Carolina, expressed himself in strong language on the subject: in substance he stated — "We (the people of South Carolina, and of the Southern States) do not wish to separate from the Union, if you will let us alone, and not impose oppressive laws upon us; but if you attempt to sacrifice our interests to the manufacturers of the Northern States,* we will separate from you, and, if necessary, we will defend our separate existence by force of arms."

On the opening of the next session of Congress (8th December, 1830), the President, in his message, said:—

"While the chief object of duties should be revenue, they may be so adjusted as to encourage manufactures. In this adjustment, however, it is the duty of the government to be guided by the general good. Objects of national importance alone ought to be protected: of these the productions of our soil, our mines, and our workshops — essential to national defence — occupy the first rank. Whatever other species of domestic industry, having the importance to which I have referred, may be expected, after temporary protection, to

* Pennsylvania was among the most decided friends of the tariff.

compete with foreign labour, on equal terms, merit the same attention in a subordinate degree."

The report of the majority of the committee on manufactures, to which had been referred this part of the President's message, was hostile to any alteration or modification of the existing tariff, — the committee expressing their belief that "the tariff, having been so recently revised, any attempt to change its provisions, at this time, would spread alarm among the great interests of our country — shake confidence in the plighted faith of Government — destroy the supposed well-founded hopes of millions of our fellow-citizens — reduce them to penury, and expose the whole country to the dangers of a most selfish policy, which might be adopted by foreign nations."

The minority of the committee published a counter report, in which they took a view of the question, respecting the tariff, diametrically opposite to that taken by the majority.

In the meantime the opposers, as well as the supporters, of the existing tariff were not idle, and a petition of the iron manufacturers of Philadelphia was presented to the Senate and House of Representatives, praying—

"1st. That all the existing duties on pig-iron, scraps, boiler-plates, and all other iron in loops, slabs, blooms, or any other state, but manufactured, and bar-iron, be abolished, or repealed, and the importation on the same be admitted free of duty.

"2nd. That all bar-iron, manufactured by hammering, be admitted, subject to the duty of April 27th, 1816, on its importation, to wit, at the rate of 45 cents per cwt.

"3rd. That all descriptions of iron manufactured by rolling, including bar, bolt, rod, sheet, and hoop, of every size and quality, be admitted, subject to a duty not exceeding that now imposed on the importation of hardware — namely, 25 per cent.

"4th. That wire of iron or steel, of all sizes and numbers, be admitted, subject to the same duty as the manufactures of wire now are, on their importation, — namely, 25 per cent.

"5th. That the duty now imposed on railroad iron, when

punched in the United States, be remitted, or a drawback of the existing duty be allowed thereon, on all sums exceeding 50 dollars.

"And, lastly, that the existing duties on steel be abolished or repealed, and the importation of the same admitted free of duty."

On the other hand, a numerous delegation from several States in the Union assembled in convention at New York, styling themselves the "Friends of Domestic Industry:" in an address to the people of the United States, they maintained the right of Congress to levy duties for the protection of manufactures as well as for revenue.

In furtherance of the objects of the convention, committees were appointed to inquire into the state of the home manufactures, and it was resolved that a committee be appointed to report on the production and manufacture of iron and steel. The commitee consisted of members from Pennsylvania, New Jersey, Rhode Island, Maryland, New York, Connecticut, Massachusetts, and Vermont. They printed a report, which contains a great deal of valuable information respecting the state of these manufactures.

The committee, in discharge of the duties assigned to them, availed themselves of the information obtained by the convention of the manufacturers of iron, recently assembled at Philadelphia; which information was originally collected for the purpose of answering the call made upon the Secretary of the Treasury at the close of the last session of Congress, and is, they have every reason to believe, as precise and accurate, in all its parts, as any body of facts, of equal magnitude and importance, which, under similar circumstances, has ever been submitted to the public.

From abstracts of statements made to that meeting, it appears that the whole quantity of iron made in the year 1830, computed in pig-iron, amounted to 191,536 tons, produced from 239 furnaces, two-fifths of which were made in Pennsylvania.

The average quantity of hammered iron imported from 1821 to 1830, was about 26,200 tons, and of rolled iron about

5600 tons, — making together 31,800 tons, valued at 1,762,000 dollars. The whole quantity of hammered and rolled iron consumed in the United States in 1830 may be estimated at about 144,666 tons.

The value of the various foreign manufactures of iron consumed, on an average, from 1821 to 1830, was about 4,000,000 dollars, making the whole amount of foreign iron and its manufactures annually consumed about 5,762,000 dollars.

The Committee concluded their report as follows: —

"The last consideration that occurs to your committee, as properly within their duty to notice, is the capability of the United States to furnish a supply of iron equal to their own wants. Of this the committee cannot entertain the smallest doubt. The tabular statements heretofore referred to show that in two years, from 1828 to 1830, the supply has increased very nearly 25 per cent.; and it is known that old establishments in many situations are enlarging, and new ones erecting,— giving assurance that this increase will be progressive, until not only the domestic market will be fully supplied, but a surplus remain for exportation, creating thereby a new source to meet the demands of foreign commerce, and additional means of employment for our navigation.

"If we compare our situation with that of Great Britain, in this particular, less than a century ago, we shall see abundant reason for self-gratulation. Ninety years since, her entire production of iron did not much exceed that which is now made in the State of New Jersey. In 1802, within the limits of a single generation, her furnaces were less in number than those now existing in the United States; and their production not more than will be made here during the present year — and this without availing ourselves of the means to which she is indebted for the extraordinary change which this comparatively short period has effected. We have the benefit of her experience — we can command her skill, if it be necessary — we have the mineral fuels, which have done so much for her, in unlimited abundance, when our forests fail — our

citizens yield to none in enterprise and ingenuity, when adequate rewards for the exercise of those qualities are held out — and, knowing this, with the experience of our rapid progress in the last two years, furnishing, as we now do, more than three-fourths of the entire consumption—is it, we repeat, extravagant to assert, that we are fully competent to supply our own wants, and furnish a surplus to minister to those of our neighbours?

"In conclusion, your committee cannot refrain from the expression of the gratification which the result of this investigation has afforded them. Deserted by the Government, and denied that protection which, at the close of the late war, was freely granted to almost every other interest—this important branch of domestic industry, so essential to the prosperity, if not to the existence, of all others, and so closely allied to real national independence, seemed threatened with absolute extinction. A wiser policy, adapted to a later period, aided by the unconquerable spirit of American enterprise, has raised it from comparative insignificance to the elevated rank it now holds; and to maintain it in which, it asks, as it believes, no sacrifice from its fellow-citizens engaged in other pursuits. Grateful for the consideration which its well-founded claims upon their justice, after years of delay and suffering, at last obtained, it is now returning to them the full measure of benefit, which it has received at their hands, and will continue to protect them, as heretofore, from speculation and monopoly from abroad — should it not a second time become the victim of that unnatural policy, which cherishes foreign, while it neglects and destroys our native industry."

No alteration in the tariff was made until the succeeding session, when an Act was passed, and approved by the President, on the 14th July, 1832—"That from and after the 3rd day of March, 1833, so much of the Act, entitled 'An Act in Alteration of the several Acts imposing Duties on Imports,' approved the 19th May, 1828, as is herein otherwise provided for, shall be repealed."

The following are the rates of duty fixed on iron, &c.: —

DESCRIPTION.	dols.	cts.	
Iron, in bars or bolts, not manufactured in whole or in part by rolling; also all iron in slabs, blooms, loops, or other form, less finished than iron in bars or bolts, and more advanced than pig-iron, except castings	0	90	per 112 lbs.
„ bar and bolt, made wholly or in part by rolling	30	0	per ton.
„ in pigs	0	50	per 112 lbs.

This alteration in the tariff was far from being satisfactory to the State of South Carolina, which persisted in opposing these laws, on the ground that it was unconstitutional to impose taxes for the purpose of protecting particular interests. They called a convention of the State, for the purpose of declaring the tariffs of 1828 and 1832 null and void within its limits; and this was not only done, but the Legislature was directed to pass laws prohibiting the collection of duties, and punishing any person who shall dare to do so after the 1st of February, 1833. The other Southern States refused to take part with South Carolina, preferring the constitutional course of applying to Congress again for a further reduction of the tariff.

On the 4th December, 1832, the Congress met, and the message of the President (A. Jackson)—at all times a subject of interest and curiosity — was this year expected with more impatience than usual, from the events which had lately taken place in South Carolina, and the menacing attitude of other southern sections of the Union. It was naturally imagined that the President would be compelled to take notice of such angry dissensions, combined with threats of resistance, and that he would detail the measures which Government had already taken, or intended to take, to allay discontent, or to insure obedience.

The message, as will be seen by the following extract, did not disappoint these expectations. After alluding to the foreign relations of the Republic, the President frankly enters upon the question of the tariff, and expresses his disapprobation, both of the principle on which it is founded, and the excessive duties which it imposes : —

"I cannot too cordially congratulate the Congress and my fellow-citizens on the near approach of that memorable happy event—the extinction of the public debt of this great and free nation. Faithful to the wise and patriotic policy marked out by the legislation of the country for this object, the present administration has devoted to it all the means which a flourishing commerce has supplied, and a prudent economy preserved, for the public Treasury. Within the four years for which the people have confided the executive power to my charge 58,000,000 dollars will have been applied to the payment of the public debt. That this has been accomplished without stinting the expenditures for all other proper objects, will be seen by reference to the liberal provision made, during the same period, for the support and increase of our means of maritime and military defence—for internal improvements of a national character—for the removal and preservation of the Indians—and, lastly, for the gallant veterans of the Revolution.

"The final removal of this great burden from our resources, affords the means of further provision for all the objects of general welfare and public defence which the constitution authorises, and presents the occasion for such further reduction in the revenue as may not be required for them. From the report of the Secretary of the Treasury, it will be seen that, after the present year, such a reduction may be made to a considerable extent, and the subject is earnestly recommended to the consideration of Congress, in the hope that the combined wisdom of the representatives of the people will devise such means of effecting the salutary object as may remove those burdens which shall be found to fall unequally upon any, and as may promote all the great interests of the community.

"Long and patient reflection has strengthened the opinions I have heretofore expressed to Congress on this subject, and I deem it my duty, on the present occasion, again to urge them upon the attention of the Legislature. The soundest maxims of public policy, and the principles upon which our Republican institutions are founded, recommend a proper

adaptation of the revenue to the expenditure; and they also require that the expenditure shall be limited to what, by an economical administration, shall be consistent with the simplicity of the Government, and necessary to an efficient public service. In effecting this adjustment, it is due, in justice to the interests of the other States, and even to the preservation of the Union itself, that the protection afforded by existing laws to any branches of national industry should not exceed what may be necessary to counteract the regulations of foreign nations, and to secure a supply of those articles of manufacture essential to the national independence and safety in time of war. If, upon investigation, it shall be found, as it is believed it will be, that the legislative protection granted to any particular interest is greater than is indispensably requisite for those objects, I recommend that it be gradually diminished, and that, as far as may be consistent with these objects, the whole scheme of duties be reduced to the revenue standard as soon as a just regard to the faith of the Government and to the preservation of the large capital invested in establishments of domestic industry will permit.

"That the manufactures adequate to the supply of our domestic consumption would, in the abstract, be beneficial to our country, there is no reason to doubt; and to effect their establishment, there is, perhaps, no American citizen who would not for a while be willing to pay a higher price for them. But, for this purpose, it is presumed that a tariff of high duties, designed for perpetual protection, has entered into the minds of but few of our statesmen. The most they have anticipated is a temporary and generally incidental protection, which they maintain has the effect to reduce the price by domestic competition below that of the foreign article. Experience, however, our best guide on this as on other subjects, makes it doubtful whether the advantages of this system are not counterbalanced by many evils, and whether it does not tend to beget in the minds of a large portion of our countrymen a spirit of discontent and jealousy, dangerous to the stability of the Union.

"What, then, shall be done? Large interests have grown

up under the implied pledge of our national legislation, which it would seem a violation of public faith suddenly to abandon. Nothing could justify it but the public safety, which is the supreme law; but those who have vested their capital in manufacturing establishments cannot expect that the people will continue permanently to pay high taxes for their benefit when the money is not required for any legitimate purpose in the administration of the Government. Is it not enough that the high duties have been paid as long as the money arising from them could be applied to the common benefit in the extinguishment of the public debt?

"Those who take an enlarged view of the condition of our country must be satisfied that the policy of protection must be ultimately limited to those articles of domestic manufacture which are indispensable to our safety in time of war. Within this scope, on a reasonable scale, it is recommended by every consideration of patriotism and duty, which will, doubtless, always secure to it a liberal and efficient support. But, beyond this object, we have already seen the operation of the system productive of discontent. In some sections of the Republic its influence is deprecated, as tending to concentrate wealth into a few hands, and as creating those germs of dependence and vice which, in other countries, have characterised the existence of monopolies, and proved so destructive of liberty and the general good. A large portion of the people in one section of the country declares it not only inexpedient on these grounds, but as disturbing the equal relations of property by legislation, and, therefore, unconstitutional and unjust.

"Doubtless, these effects are in a great degree exaggerated, and may be ascribed to a mistaken view of the considerations which led to the adoption of the tariff system; but they are, nevertheless, important in enabling us to review the subject with a more thorough knowledge of all its bearings upon the great interests of the Republic, and with a determination to dispose of it so that none can with justice complain.

"It is my painful duty to state that, in one quarter of the United States, opposition to the revenue laws has risen to a

height which threatens to thwart their execution, if not to endanger the integrity of the Union. Whatever obstructions may be thrown in the way of the judicial authorities of the General Government, it is hoped they will be able peaceably to overcome them by the prudence of their own officers and the patriotism of the people. But should this reasonable reliance on the moderation and good sense of all portions of our fellow-citizens be disappointed, it is believed that the laws themselves are fully adequate to the suppression of such attempts as may be immediately made. Should the exigency arise rendering the execution of the existing laws impracticable from any cause whatever, prompt notice of it will be given to Congress, with the suggestion of such views and measures as may be deemed necessary to meet it."

The resistance of the people of South Carolina to the fiscal laws of the Union, threatened the Confederation with an immediate civil war, or with a political separation. To ward off such a catastrophe, the President issued a proclamation against the revolters of the refractory State, and, at the same time, ordered his ministers to introduce into the Legislature measures which might prevent the necessity of resorting to violence.

These measures were a tariff bill, sanctioned by Government, which was reported with all convenient speed in the House of Representatives, obviously designing, by the satisfactory reduction of duties before the 1st of February, to deprive the inhabitants of South Carolina of all pretext for putting into execution the great project of resistance which they had fixed for that date. On almost all manufactured articles the reductions were considerable.* The other mea-

* On iron, in bars or bolts, not manufactured in whole or in part by rolling, a duty at and after the rate of 18 dollars the ton, until the 2nd day of March, 1834, inclusive; and thereafter a duty at and after the rate of 15 dollars the ton.

On bar and bolt-iron, made wholly or in part by rolling, a duty at and after the rate of 30 dollars the ton, until the 2nd day of March, 1834, inclusive; and thereafter a duty of 24 dollars the ton, provided that all iron in slabs, blooms, or other form less finished than iron in bars or bolts, and more advanced than pig-iron, except castings, shall be rated as iron in bars and bolts, and pay duty accordingly.

sure was a bill introduced into the Senate, for more effectually enforcing the duties of customs, so long as they should be exacted.

The State of South Carolina extended the term from the 1st February to the 3rd March, to give an opportunity for the passing of some satisfactory measure by Congress.

The bill for the regulation of the tariff was disputed in the House for nearly two months—it was opposed by both parties, and could give satisfaction to neither. The permanent committee of the New York Convention drew up a series of resolutions against it; and the committee on agriculture, who had been instructed to inquire into the influence which the encouragement given to the manufacturing interests of the State had upon the interests of agriculture, and upon the purchase and settlement of the unseated lands of the Commonwealth, also reported against the reduction of duties. In the Senate likewise the Enforcing Bill met with great and violent opposition. The session was drawing to a close, and nothing had been done. The termination not only of the session, but of the 22nd Congress, was to take place on the 2nd March; and though a new election, and a long interruption of legislative labours were to intervene, nothing had been effected to pacify the plantation states, or to quell the threatened insurrection in South Carolina. Under these circumstances, Mr. Clay, alarmed at the view of political affairs, brought forward a new tariff bill in the Senate, which met with the support of Mr. Calhoun, the senator from South Carolina, and of other senators from the southern section of the Union, being cordially received as the pledge of peace.

It was entitled a bill* "To modify the Act of the 14th July, 1832, and all other acts imposing Duties on Imports." The first section fixes all duties at 20 per cent. *ad valorem*, after 1842.

"That from and after the 31st day of December, 1833, in

On iron, in pigs, a duty at and after the rate of 50 cents for every 112 lbs'. weight, until the 2nd day of March, 1834, inclusive; and thereafter a duty at and after the rate of 40 cents. for every 112 lbs'. weight.

* Called "The Compromise Act."

all cases where duties are imposed on foreign imports, by the Act of July 14th, 1832, entitled 'An Act to alter and amend the several Acts imposing Duties on Imports,' or by any other act, shall exceed 20 per cent. on the value thereof, one-tenth part of such excess shall be deducted; from and after the 31st day of December, 1835, another tenth part thereof shall be deducted; from and after the 31st day of December, 1837, another tenth part shall be deducted; from and after the 31st day of December, 1839, another tenth part thereof shall be deducted; and from and after the 31st day of December, 1841, one-half of the residue of such excess shall be deducted; and from and after the 30th day of June, 1842, the other half thereof shall be deducted."

This bill, as well as the Coercion Bill, passed both Houses, and were approved by the President on the 2nd March, 1833.

The statements of the votes on the two measures are important, as indications of the complete separation in commercial interest and political feeling between the different sections of the great American Union.* It will be seen that the new

* VOTES IN THE UNITED STATES CONGRESS ON THE TARIFF AND ENFORCING BILLS.

Tariff Bill.

States.	Ayes.	Noes.	Absent.	Total.
Maine - - - - -	6	1	0	7
New Hampshire - - -	4	1	1	6
Massachusetts - - -	0	13	0	13
Rhode Island - - -	0	2	0	2
Vermont - - - -	0	5	0	5
Connecticut - - - -	0	6	0	6
	— 10	— 28	— 1	— 39
New York - - - -	11	19	4	34
New Jersey - - - -	0	6	0	6
Pennsylvania - - -	4	21	1	26
Delaware - - - -	0	1	0	1
Maryland - - - -	9	0	0	9
	— 24	— 47	— 5	— 76
Virginia - - - -	20	1	0 [1]	21
North Carolina - - -	13	0	0	13
South Carolina - - -	9	0	0	9
Georgia - - - -	6	0	1	7
Alabama - - - -	3	0	0	3
Mississippi - - - -	1	0	0	1
Louisiana - - - -	3	0	0	3
	— 55	— 1	— 1	— 57

[1] Add Speaker (Stevenson), who did not vote, of course.

tariff, which is to deprive manufacturing industry of all protection after the year 1842, is opposed by twenty-eight out of

States.	Ayes.	Noes.	Absent.	Total.
Kentucky	12	0	0	12
Tennessce	9	0	0	9
Ohio	7	6	1	14
Indiana	2	1	0	3
Illinois	1	0	0	1
Missouri	0	1	0	1
	— 31	— 8	— 1	— 40
	120	84	8	212

Enforcing Bill.

Maine	7	0	0	7
New Hampshire	4	1	1	6
Massachusetts	13	0	0	13
Rhode Island	2	0	0	2
Vermont	5	0	0	5
Connecticut	5	0	1	6
	— 36	— 1	— 2	— 39
New York	27	3	4	34
New Jersey	0	3	3	6
Pennsylvania	24	1	1	26
Delaware	1	0	0	1
Maryland	8	0	1	9
	— 60	— 7	— 9	— 76
Virginia	8	13	0[1]	21
North Carolina	9	3	1	13
South Carolina	3	6	0	9
Georgia	1	6	0	7
Alabama	0	3	0	3
Misssisippi	0	1	0	1
Louisiana	3	0	0	3
	— 24	— 32	— 1	— 57
Kentucky	7	4	1	12
Tennessce	7	2	0	9
Ohio	11	1	2	14
Indiana	3	0	0	3
Illinois	0	0	1	1
Missouri	1	0	0	1
	— 29	— 7	— 4	— 40
	149	47	16	212

On the passage of the Enforcing Bill in the Senate, there was but one vote in the negative, that of Mr. Tyler, of Virginia. Fifteen senators were absent,

[1] Add Speaker.

thirty-eight votes in the Northern States, and by forty-seven out of seventy-one in the Eastern, while, in the Southern, it is supported by fifty-five out of fifty-six, and in the Western by thirty-one out of thirty-nine. On the contrary, it will be observed, that the Enforcing Bill was supported by thirty-six out of thirty-seven votes in the Northern, and by sixty out of sixty-seven in the Eastern States, whilst its opposition in the Southern was reduced to thirty-two out of fifty-six, and in the Western to seven out of thirty-six.

The President still continued to make preparations for compelling the South Carolinans to obey his authority, but his instructions to the officer in command at Charlestown proved his moderation of temper, and his anxious wish for an amicable adjustment. And this object was attained; the passing of the Tariff Act gave great satisfaction; they considered it as an abandonment of the existing system, and an engagement that industry should henceforward be released from all fiscal regulations. The South Carolina Convention for organising resistance to the enforcement of the tariff, in consequence resigned its office, and by the following "ordinance" nullified its own nullification acts: —

"Whereas, the Congress of the United States, by an Act recently passed, has made such a reduction and modification of the duties on foreign imports as amounts substantially to an absolute reduction of the duties to the revenue standard;

viz., Messrs. Seymour, of Vermont; Smith, of Maryland; Brown and Mangum, of North Carolina; Calhoun and Miller, of South Carolina; Troup, of Georgia; King and Moore, of Alabama; Black and Poindexter, of Mississippi; Bibb and Clay, of Kentucky; and Benton and Buckner, of Missouri. About eight of these gentlemen, had they been present, would have voted against the bill.

Bringing together the votes in the Senate and House of Representatives in one view, they afford the following results:—

	Tariff Bill.		*Enforcing Bill.*	
States.	Ayes.	Noes.	Ayes.	Noes.
New England - - - - -	16	34	38	1
Middle States, including New York	32	52	69	7
Southern - - - - - -	67	1	28	33
Western - - - - - -	37	13	37	7
	152	100	172	48

and that no higher duties shall be laid than may be necessary to defray the economical expenditures of the Government:—

"It is, therefore, ordained and declared, that the ordinance, entitled 'An Ordinance to nullify certain Acts of the Congress of the United States, purporting to be Laws laying Duties on the Importation of Foreign Commodities,' and all acts passed in pursuance thereof, be henceforth deemed and held to have no force or effect, provided that the Act, entitled 'An Act further to alter and amend the Militia Laws of this State,' passed on the 20th day of December, 1832, shall remain in force until it shall be repealed or modified by the Legislature."

IRON MANUFACTURES OF THE UNITED STATES IN 1840.

From the Aggregate of the Statistics on the 1st June, 1840, taken by the Marshals, in pursuance of an Act of Congress passed the 3rd March, 1839.

States and Territories.	Cast-iron.		Bar-iron.		Tons of Fuel consumed.	Men employed, including Mining Operations.	Capital invested.
	No. of Furnaces.	Tons produced.	Bloomeries, Forges, and Rolling Mills.	Tons produced.			Dollars.
Maine - - -	16	6,122	1	- -	285	48	185,950
New Hampshire	15	1,320	2	125	2,104	121	98,200
Massachusetts -	48	9,332	67	6,004	199,252	1,097	1,232,875
Rhode Island -	5	4,126	- -	- -	227	29	22,250
Connecticut -	28	6,495	44	3,623	16,933	895	577,300
Vermont - -	26	6,743	14	655	388,407	788	664,150
New York - -	186	29,088	120	53,693	123,677	3,456	2,103,418
New Jersey -	26	11,114	80	7,171	27,425	2,056	1,721,820
Pennsylvania -	213	98,395	169	87,244	355,903	11,522	7,781,471
Delaware - -	2	17	5	449	971	28	36,200
Maryland - -	12	8,876	17	7,900	24,422	1,782	795,650
Virginia - -	42	18,810	52	5,886	36,588	1,742	1,246,650
North Carolina	8	968	43	963	11,598	468	94,961
South Carolina	4	1,250	9	1,165	6,334	248	113,300
Georgia - - -	14	494	29	- -	630	41	24,000
Alabama - -	1	30	5	75	157	30	9,500
Louisiana - -	6	1,400	2	1,366	4,152	145	357,000
Tennessee - -	34	16,129	99	9,673	187,453	2,266	1,514,736
Kentucky - -	17	29,206	13	3,637	35,501	1,108	449,000
Ohio - - - -	72	35,236	19	7,466	104,312	2,268	1,161,900
Indiana - - -	7	810	1	20	787	103	57,700
Illinois - - -	4	158	- -	-	240	74	40,300
Missouri - -	2	180	4	118	300	80	79,000
Michigan - -	15	601	-	- -	451	99	60,800
Wisconsin - -	1	3	- -	- -	1	3	4,000
Total - -	804	286,903	795	197,233	1,528,110	30,497	20,432,131

The Tariff Law, commonly called the "Compromise Act," passed on the 14th July, 1832, came into operation on the 2nd March, 1833; it provided that certain reductions should be progressively made at specified periods between 1833 and 1842, when the duties were in most instances to be reduced to 20 per cent. *ad valorem.* The law was allowed to take effect for a few years; but as the reductions came into practical operation the manufacturers began to set up fresh claims for protection. And in 1842 a Bill was brought forward, called "An Act to provide Revenue from Imports, and to change and modify existing Laws imposing Duties on Imports, and for other Purposes." The Bill contained a clause authorising *the distribution of the proceeds of the sales of the Public Lands.*

This Bill passed the House of Representatives, and the Senate also passed it on the 6th August, by a majority of two votes, 25 to 23. The Bill was sent to the President (Mr. John Tyler*), who put his veto upon it on the 9th August, 1842. In returning the Bill he gave the following amongst other reasons for the course he had pursued:—

"Indeed, there is but too much ground to apprehend that even if this Bill were permitted to become a law, alienating as it does the proceeds of the land-sales, an actual deficit in the Treasury would occur, which would more than probably involve the necessity of a resort to direct taxation.

"Let it be also remarked that 5,500,000 dols. of the public debt becomes redeemable in about two years and a half, which, at any sacrifice, must be met; while the Treasury is always liable to demands for the payment of outstanding Treasury notes. Such is the gloomy picture which our financial department now presents, and which calls for the exercise of a rigid economy in the public expenditures, and the rendering available of all the means within the control of the Government.

* Mr. Tyler was Vice-President at the death of General Harrison. It is the only instance of the succession of the Vice-President to the chief magistracy.

General William Henry Harrison's inaugural address is dated the 4th of March, 1841; he died on the 4th of April following, after an illness of eight days.

"I most respectfully submit whether this is a time to give away the proceeds of the land sales, when the public lands constitute a fund which, of all others, may be made most useful in sustaining the public credit. Can the Government be generous and munificent to others when every dollar it can command is necessary to support its own wants? And if Congress would not hesitate to suffer the provision of the Act of the 4th of September last to remain unrepealed in case the country was involved in war, is not the necessity for such a course now just as imperative as it would be then?

"A third object remains to be urged, which would be sufficient in itself to induce me to return the Bill to the House with my objections. By uniting two subjects so incongruous as tariff and distribution, it inevitably makes the fate of the one dependent upon that of the other in future contests of party. Can anything be more fatal to the merchant or manufacturer than such an alliance? What they most of all require is a system of moderate duties, so arranged as to withdraw the tariff question, as far as possible, completely from the arena of political contention. Their chief want is permanency and stability.

"Such an increase of the tariff I believe to be necessary, in order to meet the economical expenditures of Government. Such an increase, made in the spirit of moderation and judicious discrimination, would, I have no doubt, be entirely satisfactory to the great majority of the American people. In the way of accomplishing a measure so salutary and so imperatively demanded by every public interest, the Legislative Department will meet with a cordial co-operation on the part of the Executive. This is all that the manufacturer can desire, and it would be a burden readily borne by the people. But I cannot too earnestly repeat, that in order to be beneficial it must be permanent, and in order to be permanent it must command general acquiescence.

"But can such permanency be justly hoped for, if the tariff question be coupled with that of distribution, as to which a serious conflict of opinion exists among the states and the people, and which enlists in its support a bare majority, if

indeed there be a majority, of the two Houses of Congress? What permanency or stability can attach to a measure which, warring upon itself, gives away a fruitful source of revenue at the moment it proposes a large increase of taxes on the people? Is the manufacturer prepared to stake himself and his interests upon such an issue?"

This is Mr. Tyler's second tariff veto. The first was to a Bill entitled—

"An Act to extend, for a limited period, the present laws for laying and collecting duties on imports," with, amongst others, the following objections:—

"It suspends—in other words, abrogates for the time—the provision of the Act of 1833, commonly called 'The Compromise Act.'" * * * *

"The Bill assumes that a distribution of the proceeds of the public lands is, by existing laws, to be made on the 1st July, 1842, notwithstanding there has been made an imposition of duties on imports exceeding 20 per cent. up to that day; and directs it to be made on the 1st August next. It seems to me very clear that this conclusion is equally erroneous and dangerous, as it would divert from the Treasury a fund sacredly pledged for the general purposes of the Government, in the event of a rate of duty above 20 per cent. being found necessary for an economical administration of the Government.

"The Bill under consideration is designed only as a temporary measure; and thus a temporary measure, passed merely for the convenience of Congress, is made to affect the vital principle of an important act."

The veto is dated 29th June, 1842.

The Bill was again immediately brought forward; it passed the Senate on the 27th August, with amendments; the amendments were concurred in by the House of Representatives; it was signed by the Speaker and the President of the Senate, and sent to the President of the United States, who also signed it, and on the 30th August addressed a protest to the House of Representatives against the course of proceeding adopted towards him. The protest concludes as follows:—

"It may be desirable, as the majority of the House of Representatives has declared it is, that no such checks upon the will of the Legislature should be suffered to continue. This is a matter for the people and States to decide; but, until they shall have decided it, I shall feel myself bound to execute, without fear or favour, the law, as it has been written by our predecessors.

"I protest against this whole proceeding of the House of Representatives as *ex parte* and extrajudicial. I protest against it, as subversive of the common right of all citizens, to be condemned only upon a fair and impartial trial according to law and evidence before the country. I protest against it, as destructive to all comity of intercourse between the departments of this Government, and destined, sooner or latter, to lead to conflicts fatal to the peace of the country and the integrity of the constitution. I protest against it in the name of that constitution, which is not only my own shield of protection and defence, but that of every American citizen. I protest against it, in the name of the people, by whose will I stand where I do, and by whose authority I exercise the power which I am charged with having usurped, and to whom I am responsible for a firm and faithful discharge, according to my own convictions of duty, of the high stewardship confided to me by them. I protest against it, in the name of all regulated liberty, and all limited government, as a proceeding tending to the utter destruction of the checks and balances of the constitution, and the accumulating in the hands of the House of Representatives, or a bare majority of Congress for the time being, of an uncontrolled and despotic power. And I respectfully ask that this, my protest, may be entered upon the journal of the House of Representatives, as a solemn and formal declaration, for all time to come, of the injustice and unconstitutionality of such a proceeding."

The Act came into operation on the 29th August, 1842.

The duty on iron	hammered	was fixed at	17	dollars per ton.
,,	rolled	,,	25	,,
,,	in pigs	,,	9	,,

The following clause was inserted in the Bill:—

"Sec. 30. And be it further enacted, that, so long as the distribution of the net proceeds of the sales of the public lands, directed to be made among the several States, Territories, and District of Columbia, by the Act entitled 'An Act to appropriate the Proceeds of the Sales of the Public Lands and to grant Pre-emption Rights, shall be and remain suspended by virtue of this Act, and of the proviso of the sixth section of the Act aforesaid, the 10 per cent. of the said proceeds directed to be paid by the said Act to the several States of Ohio, Indiana, Illinois, Alabama, Missouri, Mississippi, Louisiana, Arkansas, and Michigan shall also be and remain suspended.

"Passed the House of Representatives, July 16th, 1842."

It is probable that the manufacturers might not have been able to carry their point, had not the Southern States been apprehensive that if they made any resolute stand against the increase of duties, and still more if they threatened to secede from the Union in the event of its being carried, they might be brought into serious difficulties by the agitation of the question as to the emancipation of their slaves. The latter, therefore, having to chose between two evils, preferred of course that which they believed to be the least, and purchased a truce for the emancipation by agreeing to the Tariff, by which comparatively high duties were again imposed on most descriptions of imported articles.

Happily, however, this system has not been so permanent as was expected. The Western and Southern States, being those most directly interested in a low Tariff, have of late years had a majority in Congress; and the apprehensions with regard to Negro emancipation, excited by the proceedings in our islands, having subsided, sounder opinions with regard to commercial matters began again to prevail in Congress. Perhaps, however, the majority now referred to, or the party of Mr. Polk, might not have endeavoured to act on those principles without the example set by England; but the great commercial reforms effected in this country during the administration of Sir Robert Peel, and more especially the last and greatest of all, the change in the Corn Laws, had a powerful

influence in the United States, and Mr. Polk's government having profited by these and other circumstances, succeeded in carrying a comparatively liberal tariff, which took effect from the 1st December, 1846: —

On iron in bars, blooms, bolts, hoops, pigs, rods, slabs, or other form, not otherwise provided for, castings, old or scrap, and vessels of cast iron,—an *ad valorem* duty of 30 per cent.

On steel in bars, cast, shear, or German,—an *ad valorem* duty of 15 per cent.

IRON MANUFACTURES OF THE UNITED STATES IN 1850.

From the "Report of the Superintendent of the seventh Census." Printed by order of the House of Representatives.

PIG-IRON.

Number of establishments in operation, 377. Capital invested, 17,346,425 dollars.

Materials used, and value:—

Ore - - -	tons	1,579,309	7,005,289 dollars.
Coal - - -	„	645,242	
Coke and charcoal -	bushels	54,165,236	

Number of persons employed, 20,448. Average wages per month, 20 dols. 76 cts. Pig-iron made, 564,755 tons; value, 12,748,777 dollars.

CASTINGS.

Number of establishments in operation, 1,391. Capital invested, 17,416,361 dollars.

Materials used, and value:—

Pig iron - - -	tons	345,553	10,346,355 dollars.
Old metal - -	„	11,416	
Ore - - -	„	9,850	
Coal - - -	„	190,891	
Coke and charcoal -	bushels	2,413,750	

Number of persons employed, 23,589. Average wages per month, 27 dols. 38 cts. Castings made, 322,745 tons; value, 25,108,155 dollars.

WROUGHT-IRON.

Number of establishments in operation, 422. Capital invested, 14,495,220 dollars.

Materials used, and value:—

Pig metal - -	tons	251,491	9,698,109 dollars.
Blooms - - -	„	33,344	
Ore - - -	„	78,787	
Coal - - -	„	538,063	
Coke and Charcoal -	bushels	14,510,828	

Number of persons employed, 13,257. Average wages per month, 25 dols. 41 cts. Wrought iron made, 278,044 tons; value, 16,747,074 dollars.

IMPORTS OF BRITISH IRON.

Years.	Tons.
1815 to 1819, average	15,097
1820 — 1824 ,,	11,832
1825 — 1829 ,,	17,491
1830 — 1834 ,,	43,630
1835 — 1839 ,,	74,346
1840 — 1844 ,,	63,099
1845 — 1849 ,,	181,662
1850	367,862
1851	464,559
1852	501,158

IMPORTS OF BRITISH HARDWARE AND CUTLERY.

Years.	Declared value.
1840 to 1844, average	£498,554
1845 — 1849 ,,	803,608
1850	1,049,903
1851	1,080,487
1852	968,492

CHAP. XII.

BELGIUM AND OTHER STATES.

BELGIUM.

The early history of the manufacture of iron in this country, formerly comprehended in the district of Gaul, having already been noticed in our chapter on France, it will be only necessary briefly to refer to it, and then pass to the present era. Karston mentions, in his "Manuel de la Métallurgie du Fer," that in Belgium the conversion of the mineral into cast-iron was first brought into operation; and he states that in 1560 there were in the province of Namur 35 furnaces and 85 forges.

Before the union of Belgium and France the trade dwindled away in the part of the provinces under the control of Austria. There were 45 furnaces, which produced about 14,600 tons per annum; and at the same period, at Liege, 18 furnaces, producing, on an average of ten years, 3933 tons. Under the French Government the production of iron was more fully developed. The furnaces were built in the circular form, and the height was raised to 25 feet,—they never before having exceeded 17 feet. The bellows in brass and wood were replaced by bellows worked by a piston. In 1806 there were in Belgium 89 furnaces, 124 forges, 35 hammers, 18 foundries, and 27 rolling-mills. After the Peace, the iron manufacture may be considered to have recommenced about 1821. In 1822 there was placed at the disposal of the King an annual sum of 1,000,000 florins for the encouragement of industry, by premiums, loans, and other means. The first object was to improve the method of smelt-

ing and manufacturing iron in the mining districts; for which purpose Mr. Cockerill, an Englishman, had been invited by the King to settle in the neighbourhood of Liege. He received a very large sum, by way of loan, in order to assist him in the extension of his works, coupled with a condition that the iron-masters of Liege and Namur should have liberty to go to his works, to learn the true principles and the latest improvements in the art. The unremitting industry of Mr. Cockerill formed a large establishment for machinery of every description, one of the most perfect establishments in Europe. At this period (1822) there were 93 furnaces, 206 forges, 68 hammers, 19 foundries, and 17 rolling-mills, producing of wrought-iron about 22,000 tons, and of cast-iron about 4500 tons. In 1824 furnaces worked on the English plan, with coke instead of charcoal, were introduced; and also the puddling-furnaces and rolling-mills.

In 1835, the Minister of Commerce, in a report to the King, stated that in the provinces of Namur, Hainault, Liege, and Luxembourg, there were 95 furnaces, 200 forges, and more than 20 rolling-mills, amongst which were seven on the English plan. The rolling-mills produced about 15,700 tons per annum. The make of pig-iron was about 100,000 tons.* In 1836 the hot-air for blast furnaces was introduced.

Xavier Heuschling, in his "Statisque Générale de la Belgique," states that in 1839 there were 45 coke furnaces and 72 charcoal furnaces, of which only 17 coke furnaces and 52 charcoal were in blast; that in the prosperous times of 1837 to 1839 the make of pig-iron was about 150,000 tons, but that in 1839 this state of affairs no longer existed, and the make of the 17 coke and 52 charcoal furnaces was calculated at 88,000 tons, of which about 44,000 tons were reduced to 29,000 tons of bar-iron.

In August, 1842, a statement appeared in the *Mining Journal*, that, "out of 58 blast furnaces, 36 have been blown

* The department of Charleroi possessed at that period nine charcoal furnaces, making about 6300 tons of pigs, and nine coke furnaces, making about 27,360 tons,—together, 33,660 tons.—*Rapport de la Chambre de Commerce de Charleroi, à M. le Gouverneur du Hainault, du* 20 *Jouillet,* 1836.

out for the last three years. There is not a single furnace at work with the hot-blast; and the lowest price at which a ton of forge-pig can be produced, under the most favourable circumstances, is 3*l.* 14*s.*" At this time Scotch pig-iron could be purchased in the Clyde at or under 40*s.* per ton.

MAKE OF PIG-IRON.

Years.	Tons.
1830	52,500
1836	118,000
1838 and 1839, average	74,325
1842	52,500
1843 and 1844, average	89,688
1845 to 1850 „	152,105

EXPORTS OF IRON.

Years.	Rails. Tons.	Pig-iron. Tons.	Manufactured of all sorts.
1831 to 1834, average	—	3,526	4,006
1835 — 1838 „	—	6,276	4,394
1845 — 1848 „	3,573 [a]	68,353	6,133
1849	—	43,267	12,288

The declared value of exports in 1849 was 9,290,160 francs.

[a] EXPORTS OF RAILS.

Years.	Tons.
1845	6,117
1846	4,185
1847	3,960
1848	32

The average number of persons employed in the mines was:—

1821 to 1830	25,980
1831 — 1840	31,500
1841 — 1844	40,894

Length of railways open in 1847, 113 leagues.

PRUSSIA.

The mining districts of Prussia are Brandenburgh, Silesia, Saxon; Thuringia, Westphalia, Rhenish.

By an official return of produce in the year 1839, it appears that the extraction of iron ores gave employment to 8790 miners, and the operations of smelting and the subsequent processes to 16,291 workpeople, making in the whole 25,081 persons.

The make of iron in the years 1837 and 1839, and the value at place of production was:—

Years.		Pig-iron and castings. Tons.	All other descriptions. Tons.	Value at place of production. £
1837	-	96,700	95,796	2,165,772
1839	-	103,350	113,558	2,386,901

By a return laid before our Houses of Parliament, it appears that a considerable improvement had taken place in the following years:—

Years.		Pig-iron and castings. Tons.	All other descriptions. Tons.	Value at place of production. £
1845	-	137,010	147,538	3,373,026
1846	-	144,705	153,250	3,694,885
1847	-	161,021	186,260	4,283,021
1848	-	141,291	136,734	3,102,118
1849	-	129,873	129,324	2,759,580

Iron ore raised from 1845 to 1849, 6,248,043 tons; value at place of production, about 2*s.* per ton; and, taking 3½ tons of ore to a ton of pig-iron, it would average a make of about 350,000 tons per annum.

By a decree dated 14th June, 1844, the import duty on pig-iron was fixed at 1*l.* per ton, as before, but the duty on bar-iron was raised from 3*l.* per ton to 4*l.* 10*s.* per ton.

In 1849, there were 1763 English miles of single railroads, and 386 miles of double lines. Capital, 21,816,000*l.*

The beauty and value of the Berlin cast-iron ornaments have already been noticed.

GERMAN COMMERCIAL UNION.

Average manufacture of pig-iron, independent of Prussia:—

Years.	Tons.
1834 and 1835 - - -	121,644
1836 to 1840 - - -	146,632
1841 — 1845 - - -	153,910
1846 1850 - - -	184,592

Length of railways open in Germany, in English miles, in the following years:—

	1846.	1848.	1850.
Miles - -	2,713	3,810	4,434

AUSTRIAN DOMINIONS.

In this empire, the iron of Styria supplies the finest steel: it is chiefly found at Eisenerst and Vanderberg; the former in the district of Ensthal, so called from the river Ens. These mines were discovered in 1712. Styria also affords coal at various places. On the east extends the Duchy of Carinthia, also yielding excellent iron; the mine Friesach, on the north, being particularly famous, as well as those on the sources of the Lyser.

D. Ure (Edition 1846) says:—"In Styria and Carinthia, more than 400 furnaces or forges may be enumerated, whose annual product is nearly 25,000 tons of iron. Carniola also contains a great many forges, and affords annually about 5000 tons." There are a great many mines of iron ore in different parts of the Hartz, which give employment to many forges, including 21 smelting cupolas.

MAKE OF IRON.

Years.	Tons.
1830 - - - - - - - -	72,429
1835 - - - - - - - -	90,619
1840 to 1845, average - - - - -	120,077
1847 — 1848 „ - - - -	165,776

PIEDMONT.

The iron mines of this country generally consist of black oxide of iron, of a nature analogous to those of Sweden. These ores are reduced in 33 smelting furnaces, 55 Catalan forges, and 105 refining hearths: the whole produce about 10,000 tons of bar-iron. (D. Ure, 1846.)

ELBA.

Although iron is not manufactured in Elba, the iron mines have been famous for so many centuries, that they cannot be passed without a brief notice. In the "Lays of Ancient Rome" they are thus alluded to: —

> "And Seius, whose eight hundred slaves
> Sicken in Ilva's mines."

Virgil mentions these mines, and supposes them to have been open at the arrival of Æneas in Italy.

They are worked in open quarries, on an enormous mass of specular iron ore perforated with cavities bespangled with quartz crystals.

There are two workings, called Rio and Terra Nuova; the last having been brought into operation at a recent period. The average quantity extracted yearly is about 15,000 tons, which is smelted in the foundries of Tuscany, Liguria, the Roman States, the Kingdom of Naples, and the Island of Corsica.

CHAP. XIII.

FROM THE YEAR 1830 to 1840.

ARRIVING now at the final chapters, the arrangement, as laid down in the concluding paragraph of the Introduction, will be carried out. The history of the home manufacture from 1830 up to the present period, with remarks upon its state and prospects, and the surprising extent of improvements in the mode of operations, will occupy attention.

The rapidity with which skill, under the tuition of science, is advancing production, is not less striking than the novel and valuable application of iron to innumerable purposes unheard of anterior to the enormous supply now always attainable in the British market.

The great and increasing importance of the iron trade to this country, caused theory and practice to be brought into play to discover the best means of improving both the quantity and the quality of the iron, and the blast furnace underwent almost every variety of form, with the exception of those which have been found most beneficial in the present day. The old charcoal furnaces, from 12 to 18 feet high, or where a good water power existed, even 28 feet, gave place to coke furnaces of 40, 50, 60, and even, in one instance, 70 feet, of which height a furnace was erected in South Wales*, but, after in vain attempting to work it, they were obliged to reduce it, which they did to the extent of 30 feet by cutting a hole in the side, narrowing the mouth, and throwing in the materials at 40 feet instead of 70. The width of the boshes also varied from 10 to 15 feet, and an experiment was tried at Muirkirk, in Scotland, where they reduced the width of

* Rees' Cyclopædia.

the boshes from 10 feet to 8; the height of the furnace being 40 feet: but it was soon found that with the same volume of blast, which was formerly applied to the ten-feet furnace, very inferior effects were now produced. The combustion, apparently, was carried to too great an extent, and the materials, owing to this circumstance, entered into fusion before the iron had imbibed a sufficient dose of the coally principle from the fuel. Another great evil which resulted from this diminution of diameter, was a friction, or retardation of the descent of the materials upon the lining of the furnace. This evil was increased, and the materials made more buoyant, by the usual volume of air elevating itself in a cone not much more than half its former area. The consequences were, that the whole mixture of coke, ironstone, and limestone, would frequently hang for an hour together, or until the blast had cleared the hearth and boshes of materials, a slip would then ensue, and bring with it a large proportion of newly-introduced matter. The introduction of this into the fusing point, before being properly heated, and long before any affinity had been established betwixt the particles of metal and the carbon of the furnace, invariably changed the quality of the metal, and caused frequent and sudden alterations from grey to white iron.* But the general average height and width of the furnaces, about thirty years back, may be taken at 40 feet from the upper surface of the hearth bottom, 11 feet across the boshes, and $3\frac{1}{2}$ feet for the diameter of the tunnel head, or furnace mouth. Till that time it had been the custom to blow the furnace with one tuyere; they now, however, at some works began to blow with two, and the beneficial effects being soon experienced, they became very generally introduced. No material alteration took place for some years, when accident in some degree discovered what now constitutes one of our greatest improvements. One of the Blendare Furnaces†, near Pontypool, built as usual, with a narrow top, carrying but little burden, and making neither quantity nor quality, by some chance gave way in the top, so

* Rees' Cyclopædia.

† Mushet's Papers on Iron and Steel.

far as to widen the filling place to 9 or 10 feet. This accident was immediately followed by a cooler top, a better quality of iron, and a greater weekly quantity; and this accidental alteration furnished a model for the construction of other furnaces at the same works. Changes of this kind are not brought about rapidly, by reasoning or knowledge of principle, but by a series of slow observations and chance circumstances. The subject is, however, now better understood, and within the last five or six years the mouth or filling place of the furnace has been very generally enlarged; and, instead of 3, 3½, or 4 feet, are now from 8 to 11 feet, and in some few instances larger.

One of the most striking varieties in the modern form of the furnace, and from which the greatest quantities of iron have been run, is the cylindrical form. Furnaces of this description are erected in many places, and amongst others at the Govan Works in Scotland, of which the following is an account of a fortnight's work:—

No. 1. Furnace,—15 feet 8 inches in diameter, 45 feet high, cylindrical, from the boshes to within a few feet of the charging plate, where it is rapidly brought in to a convenient diameter for the tunnel head. Blown in 21st November, 1840.

Two weeks, ending December 12th, produced—

1st week	140 tons	1 cwt.	No. 1. iron.	1st week stopped 12 hours.
2nd do.	145 „	6 „		

Blown with hot air, and 5 tuyeres, pillar of blast—3 lbs. per square inch, at tuyere pipes.

No. 2. Furnace,—15 feet diameter, cylindrical, 45 feet high.

1st week	128 tons	15 cwt.	stopped 12 hours, No. 1. iron.
2nd do.	150 „	11 „	

No. 3. Furnace,—Out of blast, being enlarged.

No. 4. Furnace,—11 feet diameter, 45 feet high, and cylindrical:—

1st week	75 tons		stopped 12 hours, No. 4. iron.
2nd do.	77 „	13 cwt.	

No. 5. Furnace,—15 feet diameter, 45 feet high, and cylindrical:—

1st week	95 tons	No. 4. iron
2nd do	116 „ 13 cwt.	stopped 12 hours

These furnaces were all blown with heated air, and have, within these few years, been erected by the proprietor, Mr. William Dixon, who made a series of experiments at the Calder Iron Works, the results of which satisfied him of the superiority of the cylindrical form, which he has here adopted. And the make is a good proof of the advantage of this form of furnace; but from 90 to 100 tons per week from a furnace is now by no means unusual; in fact, throughout most of the works of South Wales the average make is seldom below 80 tons per week, but more generally as above stated.

But the boldest and most successful alteration in the form of the blast furnace was made by Mr. John Gibbons, of Corbyn's Hall. The account of his furnace was published by himself in a small pamphlet, and circulated amongst his friends. Mr. Gibbons' furnace is considered the best in Staffordshire, for the duration of the hearth and boshes, working to good yields, making good iron, and greatest quantity. The duration of the hearth and boshes appears to arise from the fact of the hearth being put in wider than they generally are, and consequently giving more room for the blast to act. The boshes commence a little above the tuyeres, and have nearly the same inclination as the curve of the furnace; the boshes, in fact, running 30 feet high; at which height is the widest part of the furnace, it being there 14 feet. Mr. Gibbons, an eminent ironmaster, a gentleman having ample opportunities of watching the blast furnace in its operations, observes, that he acquired the habit of observing with much attentive interest the changes effected by fire in its inner form; his attention was first more particularly directed to the very rapid destruction that takes place in the hearth and boshes during the early period of the furnace being worked: "at the end of six months it may, I believe, be safely stated as a general fact, that both of them have been carried away to the extent of at least a third of their substance. From thi time, or about this time (for exact accuracy cannot be obtained on such a subject), the destruction

becomes gradual, and proceeds more or less slowly, till the boshes, either in some part of their circle, or the whole of it, are obliterated; and this may be called the natural death of the furnace—it will carry on its operations no longer." "The hearth may be replaced or repaired from without for an indefinite period, but the boshes are beyond our reach, and when they are gone, the case is hopeless—the furnace must be blown out." Mr. Gibbons' observations extend in the second place to the upper part of the furnace. He states, that it appeared to him, if he at once *made* the room which the furnace *makes* for itself by a rougher operation, "I might probably preserve thereby a considerable portion of my hearth and boshes. I put in my hearth stones as wide asunder as the pillars of the stack would allow; I cut them upwards from the tuyeres to their junction with the boshes in a diagonal line, so as to bring them into the same, or nearly the same angle with the boshes, and I certainly found that my purpose was thus far answered.* The furnace lasted longer, the hearth did not call for repairs so soon; and there was this additional advantage, I arrived at my full burden and average make for months before the accustomed period." The second alteration Mr. Gibbons considers of even more importance:—From the appearance of the lining bricks, it was evident that in the old form of furnace, the heat in the upper part had little intensity, the fire-bricks were barely glazed. With the view, therefore, of accumulating heat in this hitherto useless part, instead of building the interior of his furnace in a straight diagonal, or nearly so, from the top of the boshes to the filling hole, or tunnel head, "I *scooped* it outwards, so far as I could do so with safety to its structure; this gave me much room upward, the effect was unequivocal, particularly in my

* Till this time the hearth-stones were put in, forming a square of $2\frac{1}{4}$ to $2\frac{1}{2}$ feet at the bottom, and running up about 7 or 8 feet; and even to the present day there is a prejudice that the fire had better form its own hearth, but Mr. Gibbons very justly observes, "If the stones *melted*, it would be true to the full extent; but they do not *melt*, they *shatter*, and detach themselves in fragments of irregular shape and size, according to their natural clefts or fissures. If he were to build a new stack, he would place the pillars wide enough asunder to admit a five-feet hearth."

yield of coal." He next increased the diameter of the tunnel head, of which he considers that eight feet will be found the proper maximum, and in that case there must be, at least, four filling holes.

"Instead of beginning to contract the interior from the usual termination of the boshes (about twelve or fourteen feet from the bottom of the hearth) I have kept widening it upwards to the height of thirty feet (more than one-half of its total height) so that my boshes being twelve feet across, the widest part of my furnace, which becomes virtually the crown of my boshes, is full fourteen feet."

By which he attained the great object of removing the boshes from the action of the fire, by giving to their plane a steeper slope, and *much* greater elevation.

Mr. Gibbons states his last six months' make as averaging 100 tons per week. His best three months' work 107 tons per week; and his best week's work 115 tons, which shows an extraordinary regularity in the working of his furnace: this is the great point to be desired, especially where good and uniform quality is required. The make "was always good grey forge-pigs."

Mr. Gibbons presses on the attention two circumstances which operate against his make; the first is the use of cinder, the second is an insufficient supply of blast, its density being only 1 lb. 13 oz. per inch, and its volume not adequate to the necessities of a common-sized furnace.* The largest blast furnaces in South Wales are those of the Plymouth iron works†

* A Furnace on the common plan,

45 feet high - -	would contain 2,660 cubic feet,
12 „ boshes - -	
4 „ filling hole	
3 „ hearth - -	

divided into two parts,

The upper half 22½ feet	1,060	„
The lower do.	1,600	„

No. 4. Corbyn's Hall Furnace.

50 feet high - - -	contains 4,850 cubic feet.
Diameter as in the text	
8 feet filling hole - -	
4 „ hearth - - -	

The upper half 25 feet	2,950	„
The lower do.	1,900	„

Mr. Gibbons says, he believes that there are not many furnaces in Staffordshire, which exceed the dimensions given of the furnace on the common plan; but he knows that some of those which work the best are only 11½ feet across the boshes.

† At the Plymouth Iron Works there are seven furnaces, all in blast, and all blown with cold air, making 700 tons of cast-iron per week on an average.—" On

at Duffryn, near Merthyr, 18 feet diameter in the boshes, and 9 or 10 feet at the filling place, the height 40 feet: so that their capacity is equal to at least 7000 cubic feet, and when at work each of them must contain at least 150 tons of ignited materials for iron smelting. There are three of these enormous furnaces into which are discharged per minute at least 20,000 cubic feet of atmospheric air, under a pressure of $1\frac{1}{2}$ lb. to the square inch.* This is below the general pressure in South Wales, which may be taken at $2\frac{1}{2}$ lbs. on the inch; these furnaces, however, thus blown, frequently make 120 tons each weekly.

We cannot but be struck with this extraordinary increase in the make of a furnace, to which various causes have conduced—larger and better-formed furnaces, improved blast, and also superior knowledge in the preparation of the materials, application of the blast, and working of the furnaces. It has been observed, that some of the furnaces which make the best work as to quality and yield, in Staffordshire, do not exceed 11 ft. 6 in. or 12 feet in the boshes. Where quality is an essential, a furnace of this size is more to be depended upon than the very large ones. All furnaces require unremitting attention on the part of the manager; and even with this attention, aided by superior knowledge, the furnace will, owing to the great difficulty there is with some materials, occasionally get out of order, in which case a change is sooner brought through in a small furnace, than a large one — it is more manageable.

We must briefly refer to another and important process in the making of iron, and which has mainly contributed to place our manufactured iron in its present high position. We speak of the puddling, an improvement for which we are indebted, as already shown in the sixth chapter, to Mr. Cort. This process, although so beneficial in itself, was nevertheless attended with a waste of about 20 cwt. of pigs to a ton of bars, or in other words, it took two tons of pigs to make one

the State and Prospects of the Iron Trade in Scotland and South Wales in May, 1839, by J. Johnson. Liverpool."

* Mushet's Papers on Iron and Steel.

ton of bars*; and for some years afterwards it required 35 to 30 cwt., even when the process became much better known: at the present time the waste does not generally exceed from 6 to 7 cwt. of pigs to a ton of bars, including the waste in the refinery.

The principal improvement in the puddling is the substitution of iron for sand-bottoms in the furnaces. At the time when the sand-bottoms were used, the puddlers seldom charged more than 2½ cwt. of metal, and could not work more than four heats in the twelve hours: the principal cause of delay arose from the puddler having to make a fresh bottom each time before he charged. Neither could they puddle pig-iron alone, in consequence of its boiling and getting mixed with the sand; the waste also was considerably more in this process than in any other mode of working.

They then tried another plan with a large metal basin to work pig; but they did not succeed, the pig melted so raw and liquid, it fastened to the edge of the basin and could not be got off by the puddler. Iron bottoms were then substituted, and are now very generally used.

In some works they have within a few years puddled all pig by a process called boiling, originating in the impression that the waste in the refinery might in a great measure be saved.

In Puddling Refined Metal. — The metal is first put in the furnace and melted: when melted, a small quantity of hammer-slag is added to ferment it, and discharge the impurities of the iron; it is then worked by the puddler till it is in a sufficient state to be dried; the damper is put down, and the iron dried, after which the damper is raised up and fresh coals put on, and the iron is puddled till it is ready to ball and be taken to the hammer.

Time melting - - - -	25 minutes.
From melting till dry - -	15 ,,
From being dried till shingled -	30 ,,
	70 ,,

* Mr. Cort made 29 tons 3 cwt. 16 lbs. of bar-iron from 60 tons of government ballast.—*Mushet's Papers on Iron and Steel*, p. 32.

Time lost in cleaning grate, charging furnace, &c. about 90 minutes in the course of twelve hours. 8 heats of $3\frac{3}{4}$ cwt. may be worked in the 12 hours.

In Boiling Pig-iron.— Before the charge is put in the furnace, a sufficient quantity of hammer-slag is put in, and then the pig-iron. Fresh coal is put on to melt the pig and hammer-slag. When it begins to melt, the puddler commences working it, and the more he works it the more it boils and the purer it is. If the iron is of good quality, it will boil for thirty or thirty-five minutes from the time it is melted. When done boiling, the cinder, which has been floating on the top of the iron, drops through it on to the plate, leaving the iron to be worked up, till by working it becomes malleable, and fit for balling. After the iron is taken to the hammer, the cinder is drawn from the furnace, and fresh hammer-slag used for the next heat.

Time melting - -	25	minutes.
Time boiling - -	35	„
Worked into a malleable state	55	„
	115	„

From the time of drawing a heat it is ten or fifteen minutes before the puddler is again able to charge. Six heats of $3\frac{3}{4}$ cwt. may be worked in the twelve hours.

There is also a difference in wages.

Say for puddling refined metal	8*s.* per ton.
„ boiling pig - -	10*s.* „

The yield also is in favour of the refined metal, not only in the puddling, but likewise in the after process of heating and rolling.

Boiling pig-iron, although not so advantageous to the ironmaster, is nevertheless generally done where they have not the convenience of refineries: it was adopted with the idea of its being a cheaper mode of working, in saving coals, labour, and yield; but this is met by the extra quantity of coals used in the puddling, bearing on a smaller make, besides which the wages are higher, and there is a greater waste

in the more expensive process. Also, a greater expense is incurred in keeping the furnace in order, as the pig-iron works hotter than the refined metal, and injures the bottom as well as the walls of the furnace.

In South Wales the boiling process has been very generally done away with, as it is not found to suit the general nature of the iron. The Staffordshire and Shropshire iron is, however, well suited for boiling, being of a strong-bodied nature, and there this method of working is still used to some extent, but more frequently where they have not refineries. Where, however, the iron is of a red short nàture, a small quantity of grey pig is very beneficial, and materially assists the quality as well as the appearance of the iron.

With the view of saving the time which is lost in heating the iron to the state in which it becomes fit for the puddler to commence his operations, there have been various contrivances for heating the fresh charge of metal, whilst the preceding heat is in progress. One plan is, to make the flue rather wider, so as to form a sort of recess for the reception of the fresh charge, which is placed there by the puddler's assistant through a small door for the purpose; and when his heat is finished, is drawn forward, and is ready for him to go on with, without any delay. The simplest method, however, is to make the body of the furnace longer than according to the old plan, and to have a second door, between where the puddler works and the stack. This affords sufficient convenience and room for the succeeding charge of metal.

With these furnaces nine heats can readily be worked by one man in twelve hours; and if, as is sometimes the case, the furnace is provided with three sets of men, instead of two, ten or even twelve heats may be finished in the twelve hours.

Economy of coal is the object of the iron master in this mode of working; and as the quantity used is nearly the same, whether the furnace be constructed on the old or new plan, there is a considerable saving. The men, however, generally prefer the usual mode of working, and make about seven heats in the twelve hours, a quantity which they seldom

exceed. The weekly average of a puddling-furnace being from 12½ to 13 tons.

The iron trade in Great Britain continued to make the most rapid progress. Mr. Mushet, in his elaborate "Papers on Iron and Steel," p. 421., states the make of 1839 as follows: —

	Furnaces in Blast.	Tons.
South Wales	122	453,880
Forest of Dean	5	18,200
Shropshire	29	80,940
Staffordshire, South	106	346,213
Ditto North	7	18,200
North Wales	13	33,800
Derbyshire	14	34,372
Yorkshire	22	52,416
Newcastle-on-Tyne	5	13,000
Scotland	54	196,960
	377	1,247,981
Lancashire Charcoal		800
	Total of Pig Iron, Tons	1,248,781

being an increase of 570,364 tons per annum on the returns of 1830.

The gradual increase of the two great districts of South Wales is shown by the following Tables of manufactured and pig-iron, conveyed on the Glamorganshire and Monmouthshire Canals, from 1831 to 1840 inclusive.

IRON CARRIED ON THE GLAMORGANSHIRE CANAL IN THE FOLLOWING YEARS:—

Names of Proprietors and Works.	1831.	1832.	1833.	1834.	1835.	1836.	1837.	1838.	1839.	1840.
Guest and Co., Dowlais - -	22,075	29,395	35,072	33,477	39,145	39,286	38,914	39,361	40,495	45,218
Crawshay & Co., Cyfarthfa and Hirwain - - - -	15,465	24,668	37,380	34,952	35,090	34,654	33,580	36,986	37,009	35,507
Thompson and Co., Peny-darran - - - - - - -	11,819	10,582	12,150	12,752	12,834	12,537	12,834	12,707	15,540	16,130
R. & A. Hill, Plymouth - -	10,498	9,200	12,093	12,073	12,631	13,573	15,353	16,143	15,762	12,922
Aberdare Co. - - - - - - -	6,903	5,997	6,964	8,497	9,261	9,981	9,830	12,247	11,307	10,327
Blakemore & Co. - - - - -	2,947	3,042	3,519	3,194	4,020	3,957	3,594	3,474	3,304	3,175
Brown, Lennox, & Co.- - -	626	757	890	1,163	1,854	2,437	2,756	3,394	4,037	2,476
Gadly's Iron Co. - - - - -	- -	- -	214	731	1,828	1,816	1,756	1,127	1,081	1,345
Taff Vale Iron Co. - - - -	- -	- -	3,461	3,739	3,068	4,723	6,171	5,198	4,246	4,902
Bute Co., Rhymney - - - -	- -	36	572	434	127	124	22			
Tons -	70,333	83,677	112,315	111,012	119,858	123,088	124,810	130,637	132,781	132,002

IRON CARRIED ON THE MONMOUTHSHIRE CANAL AND TRAM ROADS IN THE FOLLOWING YEARS:—

Names of Proprietors and Works.	1831.	1832.	1833.	1834.	1835.	1836.	1837.	1838.	1839.	1840.
J. and C. Bailey, Nanty Glo	17,866	21,333	21,007	22,594	24,957	25,384	23,981	25,263	24,945	26,662
Kendall and Co., Beaufort	5,150	6,052	2,257							
Harfords and Co., Ebbw Vale and Sirhowy	18,778	19,740	19,226	20,228	25,392	23,120	22,475	23,579	25,342	24,199
Kenricks and Co. Varteg	11,519	11,171	10,627	14,762	14,831	11,209	7,753			
British Iron Company, Abersychan	8,022	7,751	7,295	8,430	9,724	12,278	10,261	11,857	12,481	12,290
Hills and Wheeley, Blaenavon	9,706	8,986	8,285	8,406	9,023	7,606	5,058			
Hills and Wheeley, Garnddyris	4,133	1,833	3,600	2,214	4,286	4,257	4,159			
Frere and Co., Clydach	6,231									
Sl. Homfray, Tredegar	13,340	13,304	12,323	12,858	13,909	12,133	12,641	15,526	14,861	15,288
Coalbrook Vale Company	2,189	2,396	2,429	2,898	3,211	3,754	3,325	4,000	5,204	7,824
Russell and Co., Blaina	2,921	7,960	4,880	6,324	9,233	8,911	6,675	7,482	1,140	
Hunt Bros. Pentwyn	4,850	4,038	4,406	4,057	6,527	8,207	6,895	1,848		
Bute Company, Rhymney	7,548	7,180	5,611	3,662	4,198	2,346				
C. H. Leigh, Pontypool	2,710	2,680	4,064	4,077	5,253	3,341	5,337	9,067	8,002	9,584
Daniels and Co., Abercarne	1,023	889	-	279	1,158	989	828	931	1,060	
Pontymister Company	1,060	1,351	239	227	1,039	1,179	1,101	2,258	2,413	
W. Russell, Machin	846	520	-	363	1,257	796	737	847	961	
J. Brown, Tydee	-	-	-	15	51	100	235	39	62	9
R. Walker, Cwm Tylery	-	64	-	66	524	520	107	159	217	
J. Kennedy, Lanhiddel	-	-	-	25	150	108	365	362	174	
J. Jenkins and Company	841	276								
Sundry Persons	432	141	168	-	-	-	-	-	-	10
J. and C. Bailey, Beaufort	-	-	5,255	9,808	12,976	14,567	11,145	10,903	10,505	10,049
Varteg Iron Company	-	-	-	-	-	-	2,669	9,857	12,820	12,669
Blaenavon Company, Blaenavon	-	-	-	-	-	-	2,092	8,074	5,718	7,347
Blaenavon Company, Garnddyris	-	-	-	-	-	-	1,456	5,688	6,708	6,955
Clydach Iron Company	-	6,542	7,252	6,261	7,618	7,640	7,081	9,283	9,606	10,038
Pentwyn Iron Company	-	-	-	-	-	-	-	2,614		
Golynos Iron Company	-	-	-	-	-	-	1,027	2,509		
Pentwyn and Golynos Company	-	-	-	-	-	-	-	2,982	12,533	17,783
Rhymney Iron Company	-	-	-	-	-	2,963	6,797	13,547	14,881	18,581
Cwm Celyn and Blaina Company	-	-	-	-	-	-	-	-	4,663	8,937
Victoria Iron Company	-	-	-	-	-	-	77	692	2,050	6,436
Tons	119,165	124,207	118,924	127,554	155,317	151,408	144,277	169,367	176,346	194,661

The most extraordinary increase, however, is in the Scotch furnaces; and this leads us, in the first place, to speak of a very important discovery, as connected with the manufacture of iron, one which has already had a great effect, and will eventually exercise the greatest influence on the trade — I mean the substitution of *hot* for *cold air* in blowing the furnaces. It was long thought that the disadvantage experienced in the summer months in the working of the furnaces, was to be attributed to the heat of the weather, and it was therefore supposed that a cold blast was most favourable to the smelting of the iron. The results obtained by the invention for the heating of the blast artificially before it passed into the furnaces, have proved how mistaken this notion was.

In 1829, Mr. Nielson, of Glasgow, manager of the gas works in that city, took out a patent for the application of hot blast in the manufacture of cast-iron.

Some experiments made by Mr. Nielson, led him to imagine that advantage would be gained by heating the air previously to passing it into the furnace; he communicated his ideas to Mr. Mackintosh, and they united in undertaking at the Clyde iron works, in concert with Mr. Wilson, one of the proprietors, a series of experiments to determine this important question.

The fuel made use of at the Clyde iron works, and in Scotland, generally, was coke, derived from splint coal.* During its conversion into coke, this coal underwent a loss of 55 parts in 100, leaving 45 of coke.

During the first six months of the year 1829, when all the cast-iron in Clyde iron works was made by means of the cold blast, a single ton of cast-iron required for fuel to reduce it, 8 tons 1¼ cwt. of coal, converted into coke. During the first six months of the following year, while the air was heated to near 300° Fahrenheit, one ton of cast-iron required 5 tons 3¼ cwt. of coal, converted into coke.

The saving amounts to 2 tons 18 cwt. on the making of one ton of cast-iron; but from that saving must be deducted the coal used in heating the air, which was nearly 8 cwt. The

* Dr. Clark, professor of Chemistry, in Marischal College, Aberdeen.

saving therefore was $2\frac{1}{2}$ tons of coal to a ton of cast-iron. But during that year, 1830, the air was heated no higher than 300° Fahrenheit. The great success, however, of these trials induced Mr. Dunlop *, and other iron masters, to try the effect of a still higher temperature. Nor were their expectations disappointed. The saving of coal was greatly increased, insomuch, that about the beginning of 1831, Mr. Dixon, proprietor of Calder iron works, substituted raw coal for coke, proceeding on the ascertained advantages of the hot blast; the attempt was entirely successful, and since that period, the use of raw coal has extended so far as to be adopted in the majority of the Scotch iron works. The temperature of the air under blast had now been raised so as to melt lead, and sometimes zinc, and therefore above 600° Fahrenheit, instead of being only 300°, as in the year 1830.

During the first six months of the year 1833, one ton of cast-iron was made with 2 tons $5\frac{1}{4}$ cwt. of raw coal—add to this 8 cwt. of coal for heating, we have 2 tons $13\frac{1}{4}$ cwt. of coal required to make a ton of iron; whereas, in 1829, when the cold blast was in operation, 8 tons $1\frac{1}{4}$ cwt. of coal was used.

The same blowing apparatus was in use during the three successive periods which have been specified; and not the least remarkable effect of Mr. Nielson's invention has been the increased efficacy of a given quantity of air in the production of iron. The furnaces at Clyde iron works, which were at first three, have been increased to four, and the blast machinery being still the same, the following were the weekly averages of iron made and coal used, not including that which was used in heating the blast:—

			Tons of Iron.		Tons of Coke.		Tons of Coal.
In 1829,	from	3 furnaces,	111	from	403	from	888
1830,	„	3 „	162	„	376	„	836
1833,	„	4 „	245	„	—	„	554

being an average of coals used in the furnace to one ton of cast-iron—

* Clyde Iron Works.

	Tons.	cwt.	qr.
1829, coke and cold air - - -	8	1	1
1830, coke and heated air - - -	5	3	1
1833, coal and heated air - - -	2	5	1

The hot blast has been introduced into many parts of England and Wales, but not with the same extraordinary effect as in Scotland. The quantity of coal consumed in the furnaces, both in England and Wales, being much less than that which is shown in the foregoing statement as having been used in Scotland before the introduction of Mr. Nielson's patent: this arises from the different quality of the coal; and as the reduced consumption of coal is at the present time its principal advantage, its introduction has not been considered of so much importance; independent of which, a strong prejudice exists with many of the iron masters, against the quality of the iron produced.

It has, however, as we have already observed, great effect on the increase of the manufacture in Scotland.

According to Mr. Finch's statement, there were in 1830, eight works in operation*, which made in that year, 37,500 tons of pig-iron.

In 1838, there were 11 works consisting of 41 furnaces in blast, and they made 147,500 tons of pig-iron, being an increase in eight years of 110,000 tons per annum. And in 1839, there were 50 furnaces in blast, making 195,000 tons, or according to Mr. Mushet, 54 furnaces producing 196,960 tons of pig-iron.† Independently of the advantage of the hot blast, the Scotch iron masters are indebted to the excellence of their ironstone called the black-band, or Mushet-stone, it being in the first instance discovered and brought into use by Mr. David Mushet. This gentleman mentions, "the discovery of this stone took place in the year 1801, in crossing the river Calder, in the parish of Old Monkland."‡

"For several years after its discovery, the use of this ironstone was confined to the Calder iron works, erected by me

* At these works there were 24 furnaces, but the statement does not show how many were in blast.

† The quantity is at the present time increased to a considerable extent.

‡ Papers on Iron and Steel, p. 121. and 127.

in the years 1800, 1801 and 1802, where it was employed in mixture with other ironstones of the argillaceous class. It was afterwards used in mixture at the Clyde iron works, and, I believe, no where else; there existed on the part of the iron trade a strong feeling of prejudice against it. About the year 1825, the Monkland Company were the first to use it alone, and without any other mixture than the necessary quantity of limestone for a flux. The success of this company soon gave rise to the Gartsherrie and Dundyvan furnaces, in the midst of which progress, came the use of raw pit coal and hot blast; the latter, one of the greatest discoveries in metallurgy of the present age, and, above every other process, admirably adapted for smelting the black-band ironstone. The greatest produce in iron per furnace, with the black-band and cold blast, never exceeded 60 tons a-week. The produce per furnace now averages 90 tons per week."

"Instead of 20, 25 or 30 cwt. of limestone formerly used to make a ton of iron, the black-band now requires only 6, 7 or 8 cwt. to the production of a ton. This arises from the extreme richness of the ore, when roasted, and from the small quantity of earthy matter it contains, which renders the operation of smelting the black-band with hot blast, more like the melting of iron than the smelting of an ore. When properly roasted, its richness ranges from 60 to 70 per cent., so that little more than a ton and a half is required to make a ton of pig-iron; and as one ton of coal will smelt one ton of roasted ore, it is evident that when the black-band is used alone, 35 cwt. of raw coal will suffice to the production of one ton of good grey pig-iron." *

From information which we have every reason to believe correct, pig-iron is, in some of the Scotch works, produced at a cost not exceeding 2*l.* per ton. We need hardly point out the effect it must have on many of our works. In North Wales they have already severely felt it, and many furnaces are blown out; it must also be severely felt by many of those works in South Wales, the high character of whose iron will not enable them to withstand its fearful competition. The

* Papers on Iron and Steel, p. 128.

resources of this Scotch mineral field appear exhaustless in coal, connected with this valuable ironstone.* It does not,

* Extract from the "Remarks on the Mineral Resources of Lanarkshire, by John Craig, Mineral Surveyor, read at the Andersonian Soiree, Dec. 12. 1836."

The coal group consists of thirty-three seams of coal, six or seven of which are generally workable. These are called by different names in different localities. In the following summary I shall adopt the Monkland nomenclature, and give the common thicknesses:—

1st. The Upper Coal, very variable, from 1 to 4 feet.
2nd. The Ell Coal, 3 to 4 feet.
3rd. The Pyotshaw, 4 feet.
4th. The Main Coal, 5 feet.
5th. The Humph Coal, $1\frac{1}{2}$ to 4 feet.
6th. The Splint or Hard Coal, $2\frac{3}{4}$ to $4\frac{1}{2}$ feet.
7th. The Virtue Well or Cleland Laigh Coal, $2\frac{1}{2}$ to 4 feet.
8th. The Killtongue Coal, 3 to 4 feet.
9th. The Drumgray Coal, $2\frac{1}{4}$ feet.

These give an average of more than thirty feet of coal. The first of these, and consequently all the others, have been deposited on an area of not less than one hundred square miles, in which I include the thirty-two square miles of new red sandstone, beneath which, save to the south of the deposit, where I consider the red sandstone to extend beyond the limit of the coal group, all the regular coal strata are to be found. The under seams, that is, those below the splint coal, extend to about 140 square miles, exclusive of that portion of them which is overlapped by trap.

The following calculation of the quantity of coal contained in the group I am attempting to describe, is made according to the estimate of Mr. Taylor, before a Committee of the House of Commons:—

The quantity of coal in a square mile of coal 12 feet thick, after leaving one-third for posts, is 8,200,000 tons. The sum multiplied by $2\frac{1}{2}$ will give the quantity contained in a thickness of 30 feet, viz. 20,500,000. This again multiplied by 100, the number of square miles in which all our coal seams are contained, gives 2,050,000,000 tons. If we take 6 feet as the average thickness of the seams occupying the remaining 40 square miles, we have, according to Mr. Taylor's calculation, for every square mile, 4,100,000 tons. Multiply this by 40, the number of square miles, and we have 164,000,000 tons; which, added to the former result, gives no less than 2,214,000,000 tons, as the quantity of workable coal contained in what is commonly called the Lanarkshire Coal Basin.

The city of Glasgow, according to the calculation of Dr. Cleland, consumed, including the different manufactories and public works, 561,000 tons in the year 1834.

Allow forty tons a-day each, to twenty-five blast furnaces, and the annual consumpt by these will be 365,000 tons. To these add 200,000 tons, as the annual consumpt of the rest of the inhabitants of the district, and the whole annual consumpt is 1,126,000 tons.

If we divide the quantity by the consumpt, we obtain a quotient of 1,966, as the number of years our common coal fields are capable of supplying a demand equal to that created by the present consumpt of the lower and middle wards of the county.

however, appear that the manufacture of bar-iron is as yet equally successful, or holds out a prospect of so decided an advantage in price over the Welsh or English, as in the case of pig-iron; the manufacture hitherto has been an expensive process, the iron being tender, and the waste being considerable. An ironmaster looks for his waste in the refinery; the hot-blast iron, besides a considerable waste in the refinery, also suffers in the after and more expensive processes; which, although it is in some measure met by the first cost of the pig-iron, nevertheless has hitherto prevented the Scotch iron masters from producing cheap bar-iron, or of a quality which will stand competition with a good description of bars, manufactured from the cold-blast pig-iron.

Although the principal advantage of this discovery is at present confined to Scotland, it may, before many years have elapsed, exercise a material influence on the manufacture of iron both in France and America. This observation arises from the circumstance of an iron master in South Wales*

Ironstones.—the principal ironstones of the upper coal series are—

1st. The Upper Black Band.
2d. Mushet's Black Band.
3d. The Crofthead Black Band. And
4th. The Shotts Coal Ironstone.

1st. The upper Black Band occurs at Palace Craig, parish of Old Monkland, being the only place where it has been found worth working. It is of inferior quality to Mushet's Band, and is no longer wrought. It is 18 inches thick, and lies about 24 fathoms above the Ell coal.

2d. Mushet's or Monkland Black Band lies about 16 fathoms below the splint coal. It is of very superior quality, measures generally from 14 inches to 18 inches thick, and occupies an area of 9 or 10 square miles in the neighbourhood of Airdrie. It forms the principal supply to Clyde, Calder, Gartsherrie, Dundyvan, Summerlea, and Chapelhall Ironworks.

3d. The Crofthead, or Slaty Black Band, is about the same thickness as the Monkland Band, and is of equally excellent quality. It lies below the coal enumerated as workable, at what distance I cannot precisely say, nor am I able to state in what extent of area it may be found. What is known of it is principally in tack by the Messrs. Holdsworth, of Coltness, who are erecting furnaces for its manufacture into pig-iron. It is found also in the estate of Langside, in the parish of Shotts.

4th. The shotts ironstones overlie the Shotts Laigh coal, and consist of a thin band with excellent nodules, in which occur immense quantities of bivalve shells, scales of fishes, &c.—*J. Craig on the Carboniferous Formation of the Lower Ward of Lanarkshire*

* Mr. Crane.

having with some success, aided by the hot blast, employed the coal called Anthracite, in the smelting of iron. Nearly twenty years back a patent was taken out, and a furnace erected on the borders of Brecknockshire, for the smelting of iron with stone coal (anthracite); many experiments were made with different proportions of the stone coal and bituminous coal used together. The iron produced was of good quality, but the object being to use the anthracite in its raw state, which could not then be effected, the furnace, after a few months' trial, was blown out. In France, also, experiments have been made. M. A. Perdonnet, in his report (1831) on the state of the iron manufacture, says—

"In the blast furnaces of France, carbonised fuel of all kinds has been tried, and the same fuel in a raw state, either wholly or mixed with the other. I will now speak of some experiments made with a curious combustible substance, called anthracite,—a kind of pure carbon, without any mixture of bitumen, compact, igniting with great difficulty, and giving out such a heat, when once in a state of combustion, that it is very difficult to procure materials for the construction of the blast furnaces which will not melt. It has been ascertained that cast-iron cannot be made with anthracite, except by excessive care, and that the furnace will not work regular unless three parts of coke be mixed with seven of the anthracite; and indeed, by reason of its burning so slowly, it has been found more advantageous to use them in equal quantities.

"The cast-iron obtained with these different proportions of anthracite has always been of excellent quality. This may cause surprise, as the combustible used without preparation as it comes from the mine always contains a large quantity of sulphur."

Mr. Crane's works are situated on the anthracite formation, and his attention has naturally for many years been directed to the application of it to smelting purposes, but without success, until the idea occurred to him that a heated blast, upon the principle of Mr. Nielson's patent, might, by its greater power, enable him to complete the combustion of this peculiar

coal. Mr. Crane, in his report to the British Association (1838), says—

"One evening, after I had placed a piece of the anthracite upon my parlour fire (which had before been made up with bituminous coal), and had allowed it to arrive at a red heat, upon my applying as fierce a blast to this piece of coal as I could raise from a pair of bellows, I noticed the appearance of a black mark or spot upon that part of it where the air impinged upon it; on my continuing the like rapid current, in the same direction, I shortly blew the fire out of it. I at once perceived that the effect of the strength of a current of air, when cold, which we of necessity are obliged to blow into our furnaces to secure the passage of the blast through the high and dense column of materials contained in an erection like a blast furnace, instead of encouraging ignition, was actually unfavourable to it. On giving the thing but a moment's reflection, the question promptly occurred to me, what would be the effect of turning a blast into a furnace upon this coal, which would itself burn—which would itself melt lead? I at once determined that it was a thought which was really worthy of mature reflection. The further consideration which I gave to the matter, and the further experiments which I shortly afterwards instituted have at length been crowned with full success."

Mr. Crane states that on an average of three months he made *the ton of iron with less than twenty-seven cwt. of anthracite coal,* not including the heating of the blast, and that the iron produced was decidedly stronger than any other before smelted at his works.*

The anthracite formation probably occupies about one-third of the mineral basin of South Wales; it commences near the upper part of the vale of Neath, in the county of Glamorgan, and proceeds in a westerly direction through the remainder of that county, thence through that of Carmarthen, and crops out in the sea, in St. Budes Bay, after passing through a con-

* Mr. Crane has three furnaces, in two of which he uses three-fourths bituminous and one-fourth anthracite; and in the third, a small cupola, he used only anthracite. Other works are being erected in this district.

siderable portion of the county of Pembroke. It is likewise found in France, Austria, Bohemia, and Sardinia, and very large deposits have been already discovered on the continent of America, particularly in the state of Pennsylvania.

It is stated that in the early part of 1840 there were fifty anthracite furnaces at work in America. On the 18th of January of that year, a dinner was given at Pottsville, Pennsylvania, by W. Lyman, Esq., on the occasion of his having successfully introduced the smelting of iron with anthracite by the use of hot blast. Mr. Nicholas Biddle, who attended to witness the result of the experiments, after expressing his entire satisfaction in their success, observes,—" And this, after all, is the great mystery—the substitution of what is called the hot blast for the cold blast. Let us see the changes which this simple discovery is destined to make. As long as the iron ores and the coal of the anthracite region were incapable of fusion, the ores were entirely useless, and the coal nearly unavailable for manufactures, while, as the disappearance of the timber made charcoal very expensive, the iron of Eastern Pennsylvania was comparatively small in quantity and high in price, and the defective communications with the interior made its transportation very costly. The result was that with all the materials of supplying iron in our own hands, the country has been obliged to pay enormous sums to Europeans for this necessary. In two years alone —1836–7, the importations of iron and steel amounted to upwards of twenty-four millions of dollars. The importations for the last five years have been about forty-nine millions of dollars. It is especially mortifying to see that even in Pennsylvania, there has been introduced within the last seven years, exclusive of hardware and cutlery, nearly 80,000 tons of iron, and that of these were about 49,000 tons of railroad iron, costing probably three millions and a half of dollars. Nay, this very day, in visiting your mines, we saw at the farthest depths of these subterranean passages, that the very coal and iron were brought to the mouth of the mines on rail tracks of British iron, manufactured in Britain, and sent to us from a distance of 3000 miles. This dependence is deplor-

able. It ought to cease for ever; and let us hope that with the new power this day acquired, we shall rescue ourselves hereafter from such a costly humiliation. We owe it to ourselves, not thus to throw away the bounties of Providence which in these very materials has blessed us with a profusion wholly unknown elsewhere. The United States contain, according to the best estimates, not less than 80,000 square miles of coal, which is about sixteen times as much as the coal-measures of all Europe. A single one of these gigantic masses runs about 900 miles from Pennsylvania to Alabama, and must itself embrace 50,000 square miles, equal to the whole surface of England Proper. Confining ourselves to Pennsylvania alone, out of fifty-four counties of the State, no less than thirty have coal and iron in them. Out of the 44,000 square miles which form the area of Pennsylvania, there are 10,000 miles of coal and iron, while all Great Britain and Ireland have only 2000; so that Pennsylvania has five times as much coal and iron as the country to which we annually pay eight or ten millions of dollars for iron. Again, the anthracite coal-fields of Pennsylvania are six or eight times as large as those of South Wales. Of these great masses it may be said confidently that the coal and the iron are at least as rich in quality and as abundant in quantity as those of Great Britain, with this most material distinction in their favour, that they lie above the water level, and are easily accessible, while many of the mines of England are a thousand or fifteen hundred feet below the surface. With these resources you would have abundant employment, if you could only supply the present wants of the country, for which we are now dependent on foreigners. But the sphere of demand is every day widening for the consumption of iron. The time has come when nothing but iron roads will satisfy the impatience of travellers and the competitions of trade. The time is approaching when iron ships will supplant these heavy, short-lived, and inflammable structures of wood. We shall not long be content to cover our houses with strips of wood under the name of shingles, prepared for the first spark, if we can have low-priced iron, in which event too, the present

pavements of our towns would be superseded by footways of iron. The only difficulty which is suggested is the high price of labour in this country. Allow me to say that I consider this a misapprehension. The high rate of wages is always put forward as the obstacle to any effort to make for ourselves what we import, but I do not believe that it ever made any serious obstacle in practice. I believe, on the contrary, that in any comparison between the price of labour in England and the United States, if we consider not the nominal price paid the labourer, but the amount of work actually done for a given sum of money, and if we regard the English poor-rates, which are only a disguised addition to the rate of wages, we shall arrive at the conclusion that labour is very little, if at all higher in the United States than in England.

"If coal and iron have made Great Britain what she is, if this has given her the power of 400,000,000 of men, and impelled the manufactories which have made us, like the rest of the world, her debtors, why should not we, with at least equal advantages, make them the instruments of our own independence."

Whether these sanguine expectations will be realised remains to be seen, but at present in this country only one small cupola, making about 35 tons per week, is worked with anthracite unmixed with any bituminous coal.

In any inquiry into the probability of injury arising to our manufactures from the competition of foreign countries, particular regard must be had to the facilities of transport, and to the existence in our own country of a mass of capital in roads, canals, machinery, &c.; and also to the cheap rate at which the abundance of our fuel enables us to produce iron, the basis of almost all machinery. It has been justly remarked by M. de Villefosse, that "Ce que l'on nomme en France, la *question du prix des fers*, est, à proprement parler, la *question du prix des bois*, et *la question des moyens de communications intérieures par les routes, fleuves, rivières et canaux.*"*

* Babbage, Economy of Machinery.

The same writer states the following to be the price of bar-iron at the forges of various countries, in January 1825.

	£.	s.	
France - - - - - - - - -	26	10	per ton.
Belgium and Germany - - - - - -	16	14	„
Sweden, at Stockholm; and Russia, at St. Petersburg - - - - - - - -	13	13	„
England, at Cardiff - - - - - -	10	0	„

In France, bar-iron, made as it usually is with charcoal, costs three times the price of the cast-iron out of which it is made.

By this statement it appears, that in England it is produced at the least, and in France at the greatest expense. The length of the roads which cover England and Wales may be stated roughly at twenty thousand miles of turnpike, and one hundred thousand miles of road and turnpike. The internal water communication of England and France may be stated as follows:—

IN FRANCE.

	Miles in length.
Navigable rivers - - - - - - - - -	4,668
Navigable canals - - - - - - - - -	915·5
Navigable canals in progress of execution (1824) -	1,388
	6,971·5 *

But if we reduce these numbers in proportion of 3·7 to 1, which is the relative area of France as compared with England and Wales, then we shall have the following comparison:—

			England.	Portion of France equal in size to England & Wales.
Navigable Rivers		Miles	1,275·5	1,261·6
Tidal Navigation†			545·9	
Canals, direct	2,023·5			
branch	150·6			
			2,174·1	247·4
Canals, commenced				375·1
		Total Miles	3,995·5	1,884·1
		Population in 1831,	13,894,500	8,608,500 ‡

* This table is extracted and reduced from one in the *Ravinet Dictionnaire Hydrographique*, 2 vols. 8vo. Paris, 1824. (Babbage.)

† The tidal navigation includes—the Thames from the mouth of the Medway, the Severn from the Holmes, the Trent from Trent-falls in the Humber, the Mersey from Runcorn Gap.

‡ Babbage.

The commercial legislation of France* has been founded, for the most part, on the desire to make that country independent of every other, and to force within itself the production of the principal articles of consumption, in spite of natural difficulties, and without any reference to their cost. This legislation received its greatest encouragement under the Imperial régime, when France was excluded from many of the markets of the world, and when, in order to possess without interruption those objects of luxury which long usage had made necessary, it appeared absolutely needful they should be created by her own industry, or grown on her own soil. And though the cost of so producing was ruinous to the consumer, and, in the long run, scarcely less so to the producer, yet the Government and the people lulled each other with the fallacy, " that the cost mattered not, as the money was spent in the nation, and the wealth of France was not expended on foreigners."

The fact, however, cannot be denied, that many of the efforts made by France to produce the commodities she had been accustomed to import, were forced upon her by her isolation, into which she was thrown by the naval superiority of Great Britain. But these efforts, however well suited to the peculiar exigencies of the time, and however creditable to the ingenuity of those who exerted them, necessarily flung the capital of France into false and unfavourable positions. When the return of the Bourbons opened to France the commerce of the world, so many interests had been created, so much labour and wealth were engaged in the production

* In 1831, a commission was appointed, consisting of George Villiers, Esq., and Dr. Bowring, to discuss, conjointly with the French Government, the commercial relations between Great Britain and France. Mr. Poulett Thomson, President of the Board of Trade, in his letter of instructions, says :—

"There are several articles of vast importance, such as *iron*, cotton manufactures and others which are the subjects of a ruinous system of legislation; but though it is obvious that a reduction of duty on them would be as important to England as advantageous to the general interests of France, yet the opposition to such an amelioration would be so powerful, that you would probably find it vain to contend against it at the present moment, and it may be only by degrees that it will be possible to introduce material alterations in this particular."

of articles which might have been more economically imported, that it was found difficult suddenly to change the legislation which gave to the French producers the benefit of a monopoly, without which they would have fallen; and their fall would inevitably have brought with it much suffering and distress.*

In France, as has already been observed in the Introduction to this work, "a very large proportion of those who are interested in the continuance of the existing commercial system, are elevated public functionaries, or are placed in immediate contact with them." It would have been idle, therefore, to have attacked great monopolies in their strongest holds. Nor can it be denied, that some of the protected manufactures are of such magnitude as to demand attention and respect. In many of them, considerable numbers of workmen are engaged; and though their employment in protected fabrics leads to the exclusion of a far more considerable number of labourers in those branches of industry whose cultivation would be the natural, instead of the forced growth of capital, yet all serious shiftings or transfer of labour cannot but involve questions of difficulty and deep concern. In the meantime, the labouring classes, impatient of the suffering which is of necessity consequent upon the changes which every alteration of the tariff brings with it, naturally ally themselves with their manufacturing masters, who demand the exclusion of the foreign articles which are in competition with their own.†

It is quite clear, that those high prices which it is the design of a protecting system to create, are wholly incompatible with an extended foreign trade; for though a Government may force its own dependents to purchase a dear or an inferior commodity, because it is national, no Government can compel an independent nation to buy a foreign commodity that is costly or bad. A protective system necessarily

* Report on the Commercial Relations between France and Great Britain, page 1.

† Ibid. p. 8.

relinquishes the markets of the world for the home market; or, if not, the public (already overcharged for the protected articles of its own consumption) must be made to pay, in the shape of premiums on exported articles, the whole difference of price to the foreign consumer, between those articles, and the similar ones which come into competition with them.*

The history of French prohibition is that of a struggle to obtain what is inaccessible, without a violation of those laws by which capital and labour should properly be governed; in other words, it is the rejection of those natural advantages which are at the command of industry, in order to acquire advantages which, after all, are denied to it. The wines of France, for instance†, afford unbounded means of exchange,

* Report, p. 16.

† J. Bowring, p. 167, Appendix, Second Report, 1834.

Address of the Merchants of Bordeaux to the Legislative Chambers.—Necessity of a Commercial Reform.

"What shall we say of iron and cast-iron which has not been repeated to satiety for years? We regard their prohibition as the chief cause of the decline of our city and of its commerce. The nations where iron appears the principal production were, in effect, precisely those which consumed the most of our productions. As an object of universal necessity, it is inconceivable that a great nation should submit to pay treble the value of a metal which her neighbours offer in exchange for commodities with which she overflows.

"If the mines of Aveyron present us already a slight diminution in the price, and lead us to hope for one more considerable, we must not forget that the expense of production is double the cost of English iron, and its transport from the mines in ships to Bordeaux two-thirds dearer than the freight from England to Bordeaux. Now let any one judge of the disadvantages which will always result to us in being obliged to supply ourselves from the produce of Decazeville, seeing that the company, in order to fabricate iron of a superior quality, is obliged to procure cast-iron from England, and to melt it again, at considerable expense, at their works, situated 100 leagues from the sea. Here are facts which pass before our eyes, and which speak more loudly than the most skilful arguments in favour of our deplorable system of protection. France ought now to see if she can reckon upon her own resources, and whether it is not time to restore the ancient relations which caused the prosperity of her southern districts, by freely admitting the products of nations which offer her such advantageous exchanges. We think, then, that it is urgent, if financial considerations, of which we are not qualified to judge, do not allow a complete abolition of duties on iron, that our tariffs should be reduced to the most moderate rate, and that iron should be admitted almost free at all times when its importation shall be justified by the wants of any enterprise of public interest, such as railroads, canals, suspension bridges, &c. This advantage is a matter of right from the instant that the increase of the public means of activity and general prosperity becomes concerned. Our maritime position induces us to turn our attention

and its consequent benefits have hereby been sacrificed to iron, which is produced only at extravagant cost, and which, when produced, is valueless, in consequence of its high price, for all purposes of foreign trade. With her iron France can buy nothing that is not French; the same with a great proportion of her cotton and her woollen manufactures; her wines open to her all the markets of the world.*

The annual sacrifice made by the agriculturists to the protected ironmasters, has been frequently allowed to be not less than from 1,500,000*l.* to 2,000,000*l.* sterling per annum. The lands cultivated in France are supposed to amount to 22,818,000 hectares, equal to 57,045,000 acres English; and it is calculated that a team of oxen would cultivate 15 hectares: hence, the quantity of ploughs employed in France are estimated at about 1,500,000. M. de la Rochefoucault represents the annual use and waste of iron at 40 kilogrammes per team; but it has been frequently estimated at 50 kilogrammes; making, for the whole consumption, 75,000,000 kilogrammes of iron, which, at 90 francs per 100 kilogrammes, consumes 67,500,000 francs, equal to 2,700,000*l.* sterling. Now, though this estimate is too high for an average calculation, it is undeniable that the iron could be imported from foreign countries at half the price; and the loss to agriculture alone must be taken at above one million sterling per annum. The annual consumption of France cannot be estimated at less than 160,000 tons of iron. The average difference of price between France and England has been for the last twenty years more than 10*l.* per ton. The smallest annual loss is therefore 1,600,000*l.* The law of 1822 has been more than ten years, that of 1814 was eight years in operation. They have cost

to anchor and chain cables, which we receive from England. The first pay from 11fr. to 16fr. 50c. per 100kil. This duty is an additional tax upon our navigation, as if it had not to struggle already against too many disadvantages. English large anchors of a superior quality, and better made than ours, are almost indispensable for large ships: chain cables being prohibited, we cannot make any observations upon the duty paid. They are smuggled: but we are too well assured of the repugnance experienced by those who are obliged to have recourse to this extremity, not to call for a change which may relieve them from that unpleasant position."

* Report, p. 27.

the French people above 30,000,000*l.* sterling in positive and direct sacrifice of the national wealth, and double that amount in indirect sacrifice. The relative prices of French and English iron are now far more remote than they were when the protective system was called into its present active operation. Ruinous losses have attended many of the iron-making adventurers; the largest of the iron companies have become bankrupt, and so far from the protecting experiment having produced the consequences anticipated by its advocates, we shall be enabled to show that its failure has been as signal as its cost has been enormous.*

The ship-owners, also, represent that one of the main causes of their non-progressive state is the burdens entailed on them by the restrictions of the French commercial system. The shipping of France, they report, consists of about 11,000 vessels employed in foreign commerce and fisheries. They calculate that 102 metrical quintals of iron are employed per 250 tons: hence 1,122,000 cwts. of iron are in use in the French commercial shipping; at 56fr. (*Enquête sur les Fers*, p. 53), its value would be 62,832,000fr. It is believed that the annual waste is about 10 per cent., say 6,283,200fr., of which more than half†, they state, is sacrificed by the shipping interests to the ironmasters of France, whose monopoly, at the same time, leads to an enormous increase in the value of timber.‡

While, on the one hand, the revenue is diminished by the operation of the restrictive system, the expenses of the State are increased on the other, wherever purchases are made for the public service, of articles whose price has been increased by protecting duty. The annual purchase of iron in France, for instance, for the naval and military services, amounts to 10,000,000fr., of which considerably more than half would be saved, if foreign iron were admitted at a moderate duty.§

* First Report on the Commercial Relation between France and Great Britain, 1832, p. 28.

† The *Enquête sur les Fers*, p. 52, gives 22fr. 40c. per quintal, as the average price of English iron from 1816 to 1828.

‡ Report, p. 34.

§ Ibid. p. 38.

The same observations as on the French restrictions may be applied to America. These are the only rivals with whom we have to contend, and even with respect to these, it is only in their own markets, where the manufacture is protected at the expense of the consumer. In the year 1842, however, our iron is to be admitted into America at a moderate duty *; and at the present time, rail-iron is admitted, under certain regulations, *duty free.*

By an Act passed on 14th July, 1832, for all iron imported for railroads or inclined planes, by any *State or Incorporated Company,* bond is to be given for the duty as usual; and when the iron shall be actually laid down, the drawback shall be allowed, or if paid, refunded. Provided no iron shall be considered railroad or inclined plane iron, but such as is prepared to be laid down *without further manufacture.* It further enacts, that the secretary of the treasury may extend the time for paying the duty bonds from time to time, *not exceeding three years.*

And if the company has paid the duty, the treasury will refund it, upon their giving bond to repay it if the *iron is not laid down within three years.*

And a certificate from the collector, of the time and quantity of import, and another certificate of its being laid down within the three years, are required, either to cancel the bond or recover the drawback.†

The great advantages possessed by our own country are, we should imagine, of a nature not to be injured by any foreign manufacture. Our works are situated on mineral fields containing coal and ironstone in abundance, both of which can be raised at a moderate cost. Fire-clay is also found in the same ground, and limestone in the immediate neighbourhood of all the mines. This may occur in particular situations in other countries; but even where it does, there are not the

* A Bill " To modify the Act of the 14th July, 1832, and all other Acts Imposing Duties on Imports." Approved by the President on the 2nd March, 1833.

† Railroad iron, as taken at the Custom House, entitled to drawback:—Bars or rails, pedestal washers, splicing plates, flat clamps, narrow and broad.

same facilities which we possess of conveying at a moderate rate the manufactured iron to the different markets for exportation or home consumption.

It is truly astonishing, when we look back and consider in how few years the iron manufacture has arrived at its present vast extent, and that this rapid increase has occasioned no heavy accumulations of stock; the iron trade, in common with all other trades, feels the effect of any general stagnation, but not from over-production—as with its growth new channels of consumption have kept pace. The endless detail into which the foundry trade branches itself, the almost universal fabrication which it embraces, consumes a very large proportion of the make: in buildings, iron is becoming a very general substitute for wood; railroads may also be particularly mentioned as consuming a very considerable quantity of mafactured as well as cast-iron, but principally the former. It would be endless to show where it has been, within a few years, introduced, but we cannot omit noticing its recent application to the building of ships. The success attending these first trials cannot but lead to the conclusion, that, for the future, ships will very generally be made of iron instead of wood, and if so, what a field it opens to the ironmaster, and how greatly it will add to the consumption! The plates of which the ships will be built must necessarily be of a very superior description of iron, involving a greater waste, and consequently increasing the consumption of the pig-iron; and those works must be benefited the quality and character of whose iron stands high—as, where the safety of hundreds or thousands of individuals is at stake, the very best iron alone should be used.

With increased facilities of procuring iron at a reasonable price, America, and also France*, provided that in this latter country the duties are reduced, will become large purchasers; and our iron trade, unlike many of the other manufactures,

* The French duties were to be taken into consideration in 1840; but the commercial treaty lingered till the misunderstanding between this country and France, on the affairs of the East, seems to have stopped it for an indefinite period.

being altogether the production of our own soil, will continue to give employment to hundreds of thousands of our population, to the great advantage of the country at large, as well, we trust, as the individual benefit of the ironmaster.

EXPORTS OF BRITISH IRON.

Years.	Tons.
1830 to 1834, average - - -	157,317
1835 — 1839 „ - - - -	236,139

FOREIGN IRON IMPORTED.

Years.	Tons.
1830 to 1834 average - - - - -	18,177
1835 — 1839 „ - - - -	23,305

FOREIGN IRON EXPORTED.

Years.	Tons.
1830 to 1834, average - - -	3,973
1835 — 1839 „ - - - -	4,606

Declared value of the exports of British iron and steel, and hardwares and cutlery, in the year 1839:—

	£
Iron and steel - - - -	2,719,825
Hardwares and cutlery - - -	1,828,521

CHAP. XIV.

FROM THE YEAR 1840 TO 1854.

It is now about fourteen years since the former part of this work was written; it concludes with stating that iron being altogether the production of our own soil, will continue to give employment to hundreds of thousands of our population, *to the great advantage of the country at large, as well, we trust, as the individual benefit of the ironmaster.* What vast changes have taken place since that time! The iron trade then holding a position of great national importance, has now increased to double the then annual make. From 1,300,000 tons to 2,700,000 tons! There can be little difficulty in showing, to the *present* advantage of the country, but more so in proving it to have been to the advantage of the manufacturer. That the trade has been greatly productive to many of the original ironmasters, there can be little doubt; amongst others, Sir John Guest, Mr. Alderman Thompson, and last, though not least, Mr. James Foster, who possessed possibly a more perfect knowledge of his trade than any other ironmaster. These gentlemen have died, leaving large fortunes, and some of the survivors are merchant princes.* The reverse of the picture points to the Messrs. Harford, of the Ebbw Vale and Sirhowy Works, whose lamentable failure was most deeply deplored; and whether the books of the ironmasters in general would

* How well Paley describes the advantages derived from wealth :—

" Money is the sweetener of human toil; the substitute for coercion; the reconciler of labour with liberty. It is, moreover, the stimulant of enterprise in all projects and undertakings, as well as of diligence in the most beneficial arts and employments."

admit of the same searching investigation as that to which the books of the Joint Stock Companies are yearly or more frequently subjected, is a matter which may admit of some doubt, when the events of the period are taken into consideration. As regards ironmasters in general we say, as we said before, that we trust it is to their benefit — there are no means of showing to the contrary — the country benefits by their exertions. But we have a test as regards Joint Stock Companies. Thirty years' experience proves that, according to all that has hitherto been done, they are not — but we will not say cannot, — be profitable.

In the management of these companies every necessary ingredient seems to be collected to lead to a beneficial result. You have as Directors some of the first and most able of the London merchants; Bankers, most able financiers; Mining talent, the best that can be procured. You have occasionally the assistance of the original proprietors of the works, which have been either leased or purchased, and although these gentlemen may by their neighbours have been called peddling managers, yet the very narrowness of their views may, for the sake of the argument, be considered beneficial in checking the reputed lavish expenditure of Joint Stock Companies; and thus, instead of by active measures bringing matters to a speedy close, they may, on the homœopathic principle, prolong existence by administering small globules.

Of what are called the managers of the works, it will be hardly necessary to speak; good salaries are offered as an inducement to parties to tender their services, and the best selection is supposed to be made. But these persons hold but a very secondary position; the management rests with others, who, under the name of local boards, visiting directors, or inspectors (physicians they have been called) by their interference take it into their own hands, and the only undivided share which the so-called manager retains, is the responsibility.

To make the picture complete, you have for the general management possibly the best arrangement which could be adopted—that of Managing Directors, consisting of two or three able and intelligent men of business, whose knowledge

of the trade, and great anxiety to show a successful result, tend to assimilate the company to a private trading firm.

And these gentlemen have under their superintendence what may be supposed to be a choice of works, which, with their original large capital, they were enabled to command. But *cui bono?* You have the solemn farce, year after year, of a general meeting of the proprietors; with rarely an exception*, a report is read to explain the various unforeseen circumstances which have occurred to militate against the expected success of the year's transactions, so as to render it impossible or inexpedient to make a dividend; a reduction in the establishment is suggested; thanks are given to the acting directors, which they well deserve for their anxious endeavours to make the best of an almost hopeless case, and the meeting separates, leaving the proprietors *to hope against hope* for another year.

The management of Joint Stock Iron Companies in foreign countries may not be carried out on the same able principles as in this country; at any rate, they do not seem more successful. A writer in the "Mining Journal," of the 27th Aug., 1842, who had just visited Belgium, thus speaks of the ironworks: "There are 58 blast furnaces in that country. Four-fifths of them belong to Joint Stock Companies, and not one of which, we regret to learn, is at present paying dividends to the shareholders."

Whence does this arise? It has been shown that the management in itself contains all that is necessary to a successful result: the companies are, in the first instance, possessed of large capitals, and nothing could be more legitimate than their original institution at a time when the trade was a perfect monopoly; and so formidable did they appear that an eminent ironmaster now living, in a letter which the writer saw, expressed a wish that the companies, like the heads of the Hydra, had but one body, and that he could at once put his foot upon them and crush them to death. How

* At a Meeting of the New British Iron Company held yesterday, a dividend was declared, making, with the distribution in February last, an aggregate of 10 per cent. for the year.—*The Times*, July 27th, 1854.

many of those who rushed into these companies would have been thankful in after years, if he had had the power of carrying his wish into effect! We again say whence does this want of success arise? Are Joint Stock Companies incompatible with success in ironmaking? On the contrary, with such arrangements as we have described, they ought to be most successful, provided that the management had the proper and sufficient means of carrying their exertions into effect. These means we consider to be *concentration* and sufficient *ready-money capital.* Without these, or at any rate the latter, no talent, no exertion, will alter the dire results of the last thirty years' experience!

When companies are first formed, the greater part of the capital is paid away either for works already erected, or else in bringing a new mineral field into operation, and by the time the works are erected and a sufficient supply of materials on the banks, the capital is pretty well exhausted; the ready sale of the iron being considered capable of yielding profit for dividend, maintaining a stock of materials, keeping the works in repair, and leaving a sufficient balance at the bankers for monthly requirements.

With respect to the first point, *concentration,* having acquired a valuable property, the advantages are manifest; you have but one establishment, and the whole weight is thrown on this one work to bring it to perfection; it stands on its own merits; it has not to carry, besides its own burden, a lame brother, the successful work cannot be marred by the unsuccessful.

But the still more important ingredient of success is money. It is not sufficient to the success of a company that it should barely have the means of carrying on the works from month to month; a sudden check comes; there is a want of demand, the bankers are resorted to; then comes a pressure on the money-market, and to pay off the extra assistance, you are compelled to sell large quantities of iron at a ruinously low price; and to whom is it sold? Why, to the ready-money proprietors of other iron-works, who, in return, will undersell you with your own iron. This is no fanciful picture. If pro-

prietors in Joint Stock Iron-works really require success, give the sinews to the management, and do not, year after year, hope against hope, while the property itself is wearing out; the country may be benefited, but not so the shareholders. The iron trade is not like our other staples; it is not reproductive. In cotton, the seed is sown, and you have yearly crops; in wool, the sheep are yearly shorn, and you still keep up your stock; but iron, once taken out of the ground, leaves nothing behind to restore the value of the property; and if a yearly sum be not laid by, you have at the termination of your lease or minerals, nothing but valueless furnaces, and land utterly useless for any purpose; the capital will be annihilated, and "like the baseless fabric of a vision leave not a rack behind."

To aid a successful result, an ironmaster must occasionally be an iron-purchaser; with ready money this can be accomplished. Then a depression in the trade is the period *to sow the seed of profit* — instead of sellers become purchasers of iron which cannot be made for the money, and store it till the improvement takes place, when you not only reap the direct and large profit, but you are also able to meet the certain and immediate demand for an advance of wages, which affects in every way the manufacture of iron. It falls upon the coal, ironstone, limestone, and labour generally, which, with the needy ironmaster, sweeps away all the profit possibly of months, making, in fact, an advance in price a positive loss. In many — we may say in most — cases upon an advance the ironmaster has to supply hundreds or thousands of tons at a low price, but made with the advanced wages, all of which might be readily met to the great advantage of the iron companies, provided they possessed sufficient capital; without it dividends can hardly be expected, because there will seldom be available profits.

We cannot leave this part of the subject without alluding to the Scotch iron trade. Has the extraordinary working of the Airdrie mineral field been of individual or even general advantage?

The make of iron in Scotland in 1830 was 37,500 tons;

soon after this time the important discovery of the hot blast and other improvements, aided by the black-band ironstone, as shown in a former part of this work, increased the make so considerably that in 1839 it amounted to 196,960 tons; and in 1842 it was 276,250 tons. A writer of the day says, "The increased make in Scotland and reduction in price are, doubtless, attributable to the discovery of the 'black band' and the application of the 'hot blast,' while unfortunately these twofold advantages have been the cause of the present state of the trade, and the depression of price — affecting, as such does, not only the ironmaster, but the collier, and furnaceman — without, as we contend, a correspondent advantage being derived by the consumer."

The Times of the 5th Dec. 1842, in a leading article refers the evil of this great increase to the Scotch system of banking. The writer observes: —

"It is much to be desired, as a preparation for that effort which must certainly be made in the next session of Parliament to put down that system of banking in Scotland which places the traders of England at a disadvantage and embarrasses the circulation of the whole kingdom, that those who have access to practical information on the subject would give it freely to the public. There is no time to be lost, if it is wished to make the proper impression on the public and the Legislature, previously to February next, and a few facts which only merchants and observant men of business can furnish, are worth numberless arguments in such a case. The following remarks, though they relate to only one branch of our native industry, the iron trade, are very much to the purpose, and will be generally acceptable: —

"'The injustice of permitting a paper circulation in Scotland while it is prohibited in England is so palpable, that it is matter of surprise the great body of English manufacturers, upon whom this paper system has inflicted such extensive injury, should not long since have taken up the question, with the view of being placed upon equal terms in the race of intense competition with which they are visited from Scotland. In confirmation of your views of the injury done

to the English dealer by the facilities afforded by the paper issues of Scotland, I will take, by way of example, one interest only—that of the iron trade, which it is well known has been long suffering from great depression.

"'Fourteen years ago the whole of Scotland scarcely produced 35,000 tons of iron per annum, the greater portion of which being absorbed at home, its influence on the English market was unknown. Last year Scotland, stimulated and encouraged by the large advances and paper issues of her banks, produced an enormous quantity of iron, with which she has deluged every part of England without the least regard to the important fact, that the demand all the time was decreasing in the same ratio that their supply increased; and what is the result? Prices have been forced down, even in Scotland, below the cost of production, the workmen in the meantime being ground to the earth to enable the masters there to continue their insane conflict with each other as to who shall produce the greatest quantity, and sell it at the lowest price! This ruinous system of over-trading has reacted with fearful severity upon the mining interests of Staffordshire and South Wales, and hence the outbreak in the month of August last, which was to be attributed entirely to the pressure upon those districts from the excessive production of the Scotch works, which has placed the English ironmasters in this position—that having to pay their workmen in hard money, while their competitors in Scotland are paying in paper, they were undersold in the market, and had no alternative but to stop their works altogether, or to reduce wages to a point which threw their men into almost open rebellion. This, be assured, is the true solution of the riots in the mining districts of August last; for whatever may be said to the contrary, neither Chartists nor corn-law agitators would have been listened to for a moment, had not distress (mainly to be traced to the immense production in Scotland) made the workmen ripe for disturbance.

"'Sir Robert Peel is the only statesman living who can successfully grapple with this giant monopoly of the paper

money in Scotland, and to him the commercial interest in England look for redress. If a paper circulation is good for Scotland, it is good for England, and there can be no valid reason why one portion of the kingdom should be favoured at the expense of the other. Common justice demands that both countries should enjoy equal privileges, and that the question of the currency should be placed on such a basis as not to give unfair advantage to any particular district or class of the community.' "

The railway mania of 1844 and 1845 gave a great stimulus to the iron trade, and the Scotch ironmasters greatly increased their make.

	Tons.		Tons.
In 1845 the shipments in the Clyde were	234,101,	leaving a stock of	250,000
1846 „ „	376,951	„	145,000

The shipments continued at about the same rate till 1851,

	Tons.		Tons.
when they amounted to - -	- 452,756,	leaving a stock of	- 350,000
In 1852 the shipments were	- 424,020	„ -	- 450,000
„ 1853 „ „	- 619,920,	„ -	- 220,000

The make had gradually increased to about 800,000 tons, which may be taken as the average of the years 1851 and 1852; in 1853, it was 700,000 tons. With the increase of make and prospect of demand, there sprang up a system of what was called *speculation*, and the prices were thereby supported; hundreds of thousands of tons of iron were sold by passing a slip of paper from hand to hand. This went on till the bubble burst, and many of the unfortunate holders of these scrip receipts were ruined. Speculation still gives a fictitious value to the iron, but the transactions are now based on warrants, the iron being actually in safe deposit and available when required; but as far as legitimate trade is concerned, it has been but a sorry business, and foreigners principally have reaped the benefit of this reckless production.

	s.	d.	
The average price in 1848 was - - -	44	5	per ton.
„ 1849 - - -	46	1	„
„ 1850 - - -	44	5	„
„ 1851 - - -	40	3	„
„ 1852 - - -	45	4	„
and in 1853 it was pushed up to	61	4	„

An extensive dealer in Glasgow thus describes the operations of the market. In his annual circular of the 31st Dec. 1851, he says, "Our pig-iron-market opened on the 1st Jan. at 45*s.*, a slow but gradual decline took place, and continued till the end of August, when it reached 38*s.* 3*d.* *Speculative buyers* then came in, whose operations drove prices up to 40*s.*; a downward course was then resumed until the end of November, when some buying took place in anticipation of a demand for spring shipments, and it rose to 40*s.*" He then alludes to the banking system:—"The unsound system so long pursued by our moneyed interest, and so much deprecated, of giving undue facilities to weak jobbers, has of late been severely censured and discouraged; and it is to be hoped that its discontinuance will give rise to a much healthier and more legitimate state of the trade, than has existed for some time past."

In 1852, "The pig-iron market opened in January *at 37s., and gradually gave way till the beginning of February, when it touched* 35*s.* 6*d.* An impression that such low and unremunerating price would not long continue then became pretty general; but the supply still far exceeding the demand, no confidence was felt in the trade until the end of April, when upon several furnaces being put out of blast, the dealers bought freely to stock, and prices resumed an upward tendency, *reaching* 40*s. towards the middle of June.* Speculation then sent prices up to 45*s.*, and on the 30th Dec. under strong speculative influence, the price was driven up to 77*s.* 6*d.*, but in the course of two days it fell to 70*s.* under the pressure of forced sales. The stock increased this year 100,000 tons. There were 113 furnaces in blast at the end of the year, and fifteen additional furnaces coming into operation."

The year 1853 "experienced violent fluctuations, with an amount of business in pig-iron undoubtedly beyond precedent." Towards the end of 1852 the price, under the influence of undue speculation, reached 75*s.*, but the desperate efforts of holders to sustain the market *in the face of so heavy a stock as* 450,000 *tons,* proved utterly futile. In January, under the pressure of a tightening money market, the price began to decline rapidly, and before the end of February a

fall of 20*s.* had taken place. The moderate rates now current led to a good legitimate demand, but *heavy speculative parcels still hung over the market,* and it was not until the end of April, when the price had reached the low point of 49*s.* to 50*s.*, *that the failure of an extensive operator gave confidence to the trade.* Even at this low figure, the unsatisfactory aspect of Eastern politics deterred dealers from buying largely; but the rapid diminution of stock, *coupled with a much-enhanced cost of production,* attracted the attention of a strong class of local speculators, and the price advanced to 69*s.* in August.

The advance in the rate of discount by the Bank of England now produced a retrograde movement, which continued with little variation till the beginning of October, when an advance took place occasioned by shipments, and a reduction in the French duties.

The nature of the French decree did not meet the expectations of some holders, but the market continued steady; a considerable portion of the stock being held off the market *on French account, and by speculation against spring demands.*"

What a history is this! What encouragement to destroy in as short time as possible so fine and valuable a mineral field! In 1830 the make was 37,000 tons, in 1851, 800,000 tons, and in 1860 if the opinions of those who ought to have some knowledge of the subject are to be believed, there will hardly be a furnace in blast in the Airdrie district, and it will fall into the category of Kent, Sussex, and Hampshire, as a place where iron was formerly manufactured. It is a clear case of "*the goose and the golden egg.*"

After the destruction of the Mushet, or Monkland Blackband ironstone, the active energies of the Scotch ironmasters might be directed to bring into operation *a patent,* which has lain dormant for many years, and with which the name of Mushet is also connected; it is a patent taken out in 1818 by Mr. Mushet, and Mr. William Crawshay, Jr., of the Cyfarthfa Iron-works, *to make iron from copper slags.** The stock

* The "Repertory of Arts, Manufactures, and Agriculture" (vol. xxxviii. second series, London, printed for J. Wyatt, Repertory Office, Hatton Garden,

must have materially increased since that time, and as anthracite has been made available in the smelting process, the

1821) contains, at page 13, a copy of "Specification of the Patent granted to William Crawshay the Younger, of Cyfarthfa Iron-works, in the county of Glamorgan, Esquire, and David Mushet, of Coleford, in the county of Gloucester, Ironmaster, for an invention or improvement for making or manufacturing bar or other iron from certain refuse slags or cinders produced in the smelting of copper ores, and in manufacturing copper. Dated April, 1818."

The following is from Bayle's Dictionary, folio edition, vol. ix. 1739. p. 263. (*If Sir Thomas Smith had had the use of the iron made by Mr. Crawshay and Mr. Mushet, he might have met with more success*) : —

"Thomas Smith, a learned English writer, and Secretary of State in the reigns of King Edward the Sixth and Queen Elizabeth, was born at Walden, in Essex, in the year 1512.

"In 1570, he was admitted into the Privy Council, and the year following was *engaged in a project for transmuting iron into copper.* Into this project he brought Sir William Cecil, Secretary of State, who had a philosophical genius, the Earl of Leicester, Sir Humphrey Gilbert, and others. The first occasion of this business was from one Medley, who had by vitriol changed iron into true copper at Sir Thomas Smith's house at London, and afterwards at his house in Essex. But this was too costly, as Sir Thomas saw, to make any profit from. He propounded, therefore, to find here, in England, the *primum ens vitrioli*, by which to do the work at a cheaper rate. Upon this, Sir Thomas Smith, Sir Humphrey Gilbert, and Medley, entered into a company, under articles to find this out; that is, that Medley should be employed in this business, at the charge of the other two, till, by the profit he should reap from the thing found out, he might bear his proportion. The place where this was to be attempted was in the Isle of Wight, or at Poole, or elsewhere. But at Winchelsea he had made the first trial, on account of the plenty of wood there. He received of Sir Thomas and Sir Humphrey an hundred and one pounds a-piece, for the buying of vessels and necessaries. They removed to Poole, thinking the *ens* of vitriol to be there, and took a lease of the land of the Lady Mountjoy, of three hundred pounds per annum, for the payment of which, Sir Thomas, with the other two, entered into a bond of a thousand pounds. While these things were in this state, Sir Thomas was sent Ambassador to France, in 1572, and a quarrel happening between Sir Humphrey and Medley, who went to Ireland, the business was discontinued for some time. But Sir Thomas revived it at his return, and persuaded the Lord Treasurer Burghley and the Earl of Leicester to enter into society about December, 1574, who deposited each an hundred pounds towards carrying on the project. Medley was now removed to Anglesey, where the fuel, earth and water were proper for his business; and the things which he undertook to perform were these two; first, to make of raw iron, good copper, and of the same weight and proportion, abating one part in six, so that six hundred tons of iron should, by boiling, make five hundred tons of perfect copper; secondly, that the liquor wherein the iron was boiled should make copperas and alum ready for the merchants, which keeping the price they then bore, should of the liquor of five hundred tons of copper be ten thousand pounds. After several trials the patent of the society was signed in January, 1574, in which the society was styled, *The Society of the New Arts;* but at last the project proved abortive; *and I make no doubt*, says Mr. Strype,

neighbourhood of Swansea might, for a time, prove a second Airdrie.

We will now turn to the general history, a more important part of the subject than the foregoing, as affecting the interest of the whole community. In 1839 the make of iron was 1,248,780 tons, with a depressed trade. With a view to its improvement it was agreed by the ironmasters, that there should be a reduction in the make of 20 per cent., to remain in force from the 22nd February to 1st July, 1840. The duties in France were to be taken into consideration this year, and it was hoped that their reduction would prove beneficial to the trade; but the commercial treaty with this country lingered till the misunderstanding on the affairs of the East stopped it for an indefinite period. Notwithstanding the agreed reduction of make, there was a considerable increase in the year 1840, attributable principally to Scotland, the quantity made being 1,396,400 tons; but in 1843 it had fallen to 1,215,350 tons.

In 1826, the Liverpool and Manchester Railway may be considered as first giving the impetus to that extraordinary change in locomotion which is binding Europe as well as England in one vast network of railways. The Bills for most of the early and important lines were brought forward between 1835 and 1840, from which time until 1844 few new lines were projected. From 1826 to the end of 1843, 2,276 miles of railway were authorized, and of which, during the same period, 1,952 miles were opened. The production of iron was thus in some measure met by this extra demand, but in 1842 the trade became greatly depressed.

A writer in the "Banker's Circular," November 18, 1842, says, "The production of iron has of late years been in excess of all probable demand for consumption. This new demand (for railways) cannot continue with the same force as in the period which elapsed from 1833 to 1841 inclusive, because of the diminished operations in constructing railways

Sir Thomas smarted in his purse for his chemical covetousness, and Gilbert seems to have been impoverished by it, and Medley was beggared."

The following relates to a different subject:—

"In 1575, Sir Thomas Smith procured an Act of Parliament for the two Universities and the two colleges of Eton and Winchester, that a third part of

in England, the reluctance of capitalists to embark their money in such undertakings, since proof of their inadequate returns for it was obtained, and the protective tariffs of foreign countries. The annual production of iron in Great Britain must be diminished considerably from the highest point to afford any chance of a sale for it at prices which will remunerate the capitalists engaged in the trade."—" We have always regarded the iron trade with great satisfaction, because it appeared to us one of the safest, soundest, and most enduring of our commercial interests. We regret exceedingly that the altered circumstances of the present times should have compelled us now to contemplate it with less cheerful anticipations." These observations were founded on the supposition of money matters remaining under the same regulations — *a restricted circulation.*

The price of bar-iron at this time (1842), in *Liverpool,* was 5*l.* 5*s.* per ton *, to which it had gradually fallen.

	£	s.	
In January, 1840, it was - - - - -	9	0	per ton.
In December, in the same year - - -	8	10	„
In April, 1841 - - - - - - -	7	15	„
In January, 1842 - - - - - -	6	10	„
In December, 1842 - - - - - -	5	5	„

It then fell to 5*l.* in April, 1843 †, and to 4*l.* 10*s.* in June, at which price it continued with a slight variation till April, 1844.

At the quarterly meeting of ironmasters in Staffordshire, in July, 1843, although the prices were so low—profitless to all, and to some of the small makers absolutely ruinous — there was no general attempt to reduce the wages; several large proprietors declaring that they were already too low. The wages of the colliers were from 2*s.* to 3*s.* per day, according to

the rent upon leases made by colleges should be reserved in corn, *paying after the rate of six shillings and eight pence the quarter, or under, for good wheat, and five shillings a quarter, or under, for good malt.*"

* The difference between the Liverpool price and the manufacturer's price at Cardiff and Newport is from 7*s.* 6*d.* to 10*s.* per ton.

† By a parliamentary return in 1845, the following appears to be the assessment of iron-works to the Property and Income Tax for the year ending 5th April, 1843:—

	£.	s.	d.
England and Wales - -	412,022	8	8
Scotland - - - - -	147,412	16	10
	£559,435	5	6

the thickness of the seam of coal, and the average of the work not above two days a week.

On the 19th of July, 1843, a deputation of South Staffordshire ironmasters waited upon Sir Robert Peel. The deputation was accompanied by Lords Hatherton and Lyttelton, and the Members for South Staffordshire and Wolverhampton. The Chancellor of the Exchequer, the Secretary for the Home Department, and the President of the Board of Trade, were present at the interview.

The business was opened by the chairman of the deputation, James Foster, Esq., who stated the extreme falling off in the demand for iron, the great depression in the price, and the consequent reduction in the wages of labour and contraction in the means of employment—together resulting in a condition of the workmen which could not be contemplated without serious apprehension. It was stated, that the object of the deputation was in no way connected with any intention of soliciting support from the Government, by way of pecuniary assistance, to enable them to continue their works in operation; but to discuss the practicability of the application of any measures by which the internal trade of the country generally could be improved, and the population maintained in a more healthy state of employment. The progressive reductions in the prices of iron, the rate of wages, and the state of pauperism, as exhibited in the enormous increase of the poor rates in the unions comprised in this district, were stated in extensive detail by other members of the deputation; and the operation of the American and the various continental tariffs was adduced, as acting most prejudicially on the iron trade of this country. It was explained, that a strong impression prevailed, that the great falling off in the exportation of commodities to the United States, resulting from the restrictions of the late American tariff, was mainly attributable to the continued exclusion of American corn, by the operation of the late adjustment of our own tariff—and which a moderate fixed duty would be calculated to remove. In conformity with this view, Mr. Thorneley stated the result of his impressions on a recent visit to the United States, and the improbability of any treaty being

negotiated without some modification of our corn laws — Sir Robert Peel stated that he should most willingly give his best attention to any remedies that might suggest themselves to the minds of the deputation; but that, *he feared the production of iron had been forced, by the requirements for railroads and other causes, so much beyond the ordinary demand that, now that these sources of consumption had been supplied, he could hold out no prospect of immediate improvement from any measures within the power of the Government.*

The members of the deputation stated, that they were nearly unanimous in the conviction that the depression under which their trade was suffering, as well as that affecting most other branches of productive industry, was attributable to the great falling off in the demand, occasioned by the vicious operation of our present money laws, and the consequent want of a sufficient circulation to maintain a range of prices adequate to the discharge of the fixed public and private burdens which form so large a proportion of the cost of production in this country; that, without some change of these laws, there was, in their opinion, but little hope of any improvement in the condition of the working classes, which would gradually approximate to that of the same classes in Ireland. — Sir Robert Peel expressed his dissent from these conclusions; and, after thanking the deputation for the temperate and judicious manner in which they had stated their views on the important objects which had engaged their attention, the conference terminated.

In the "Times" of the 21st June, 1843, an article appeared, taken from the "Monmouthshire Merlin." After speaking of the failure of Messrs. Harford and Davis, the writer goes on to say, "The present state of the iron trade annihilates hope — we see nothing but ruin before us and behind us. The kingdom for a few years past has been making iron in enormous quantities. Capital, accumulated annually from extensive orders and large sales, was laid out in building new furnaces, opening fresh mines, exploring mineral districts hitherto untouched. The large fortunes already secured in times when the foreign markets were all our own, and the produce at home scarcely sufficient for the demand, arrested the eager eyes of small

capitalists, and induced the formation of companies, into which the whole livings of professional men and private individuals of comfortable means were recklessly cast — each member of every company so formed expecting to be at least a Bailey, a Guest, or a Crawshay, if not eventually a Peel or an Arkwright. Then also another new invention for realising large per centages exaggerated the evil. The joint-stock banking companies opened their ledgers with profuse generosity, and advanced money upon anticipated calls, to realise immediately schemes the most gigantic and costly in the history of iron-making. Thus we saw furnace after furnace, almost in geometrical proportion, starting up, and sending forth its huge volumes of smoke and blaze into the evening sky. Towns were built as though by the aid of some Genius of the Eastern Lamp in the wilderness and upon the mountain side. Capacious houses for genteel clerks, acute managers, and roving directors, flanked the long vista of a beautiful front elevation; and thus the legitimate ironmaster, having already overlaid his market by bestowing all his surplus capital for the extension of his works, found himself also, in his turn, over-laid by an accession of a swarm of adventurers in the trade, armed with plenty of money, profuse in expenditure, and the ignorant tools of those 'wise in their generation.' If it had been a law of nature that the whole world should, for a given number of years, be clothed in iron, be domiciled in iron, sleep upon iron, ride upon cast-iron horses, and in cast-iron chariots, no greater zeal to give effect to the law could have been displayed than that which has prompted the production of a vast mass of iron at the juncture and under the circumstances which we have attempted to describe. The result is a collapse of the whole trade — a fatal reaction — doubt and dismay. In very many instances — we should say generally, with one or two particular exceptions, dependent upon favourable contracts — the ironmasters are losing nearly 1*l.* sterling per ton upon their make; and that too in establishments where the strictest economy is practised, the greatest skill exercised, and the vigilant eye of a prominent member of the firm always upon the works. What, then, must the Joint Stock Company be losing, with

its double establishment of clerks, its committees and town-offices, its everybody's work, and nobody's work? At least 10*s.* per ton additional. The 'fix,' as the Americans call it, is most disastrous. The question is, who shall blow out and retire? Are the great and ancient houses in the iron trade to retreat before the companies, or the companies before them? Is the small and respectable ironmaster to be smashed in the conflict? This is the matter at issue; and which party soever may ultimately gain the victory, its path will be strewn with the wreck of property, and the ruins of many estimable men. The trade must retire within its proper limits. But how that is to be effected — who are to stand, who to fall — what is to become of the unemployed—how starvation is to be arrested, and the ruin of thousands averted— are questions beyond our province to unravel, but which must be met boldly and in the face, because they are not to be avoided — they are already at our doors."

At the time of this distress the make of iron was 1,200,000 tons; in 1847 it had increased to 2,000,000 tons*, and in 1852 to 2,700,000 tons.

The great increase in the manufacture is mainly attributable to the railway mania, which commencing in 1844 arrived at its height in 1846.

* The following return was presented to the Houses of Parliament of the number of furnaces in blast, and the make of iron, in the year 1847:—

Districts.	In.	Out.	Total.	Tons.
North Staffordshire - -	16	3	19	65,520
South Staffordshire - -	77	62	139	320,320
Shropshire - - - - -	28	6	34	88,400
Derbyshire - - - - -	20	10	30	95,160
Yorkshire - - - - -	23	5	28	67,600
Newcastle-on-Tyne - -	24	12	36	99,840
Scotland - - - - -	89	41	130	539,968
North Wales - - -	5	6	11	16,120
South Wales - - -	151	45	196	706,680
Total - - -	433	190	623	1,999,608

In 1844	Parliament	authorized	805	miles of railway.
1845	„	„	2,700	„
1846	„	„	4,538	„
1847	„	„	1,354	„
1848	„	„	330	„

The average price of *railway iron in Wales* (Cardiff and Newport), was —

	£	s.	d.
In 1843 - - - - - - -	6	9	0
„ 1844 - - - - - - -	6	14	3
„ 1845 - - - - - - -	10	15	10
„ 1846 - - - - - - -	10	6	8
„ 1847 - - - - - - -	9	0	4
„ 1848 - - - - - - -	6	2	10

The railway history is so intimately connected with that of the iron trade, that we shall be excused for transcribing a short account of the railway mania and subsequent events, written in 1849 *, some few months after they occurred, which, together with the continued increase of make, reduced the trade to a state of extreme depression.

"Few systems have had to contend with trials more searching, or times more severe, than the railway. The early struggles for existence which every new-born system has to endure in this country, have already been brought under notice; these past and overcome, then came the violent burst of popular feeling in its favour, at a season (1845) when many combined causes prevailed to induce an *over estimate* of its value. The public had witnessed the success of those who were the *first* proprietors of shares in the Liverpool and Manchester Railway, the Grand Junction Railway, and the London and Birmingham Railway. Dazzled by the profits that had been received from these undertakings, they eagerly grasped at *original* shares in new lines, deeming the same success awaited them. The results and consequences are well known; many were ruined! because in those days when giddy speculation of all sorts abounded, men bought shares at an advanced premium in a line not even commenced. Then succeeded a reaction most lamentable in its effects, prostrating

* "The Railways of the United Kingdom statistically considered."

at once those who had been blinded by the illusive prosperity of the period, and retarding the advancement of good *bonâ fide* projects. The public omitted in their calculations the element of *time*.

"The vicissitudes of the period did not end here. The public became alarmed, and panic followed panic in quick succession, reducing to a nominal value the better class of shares. Scarcely had these panics commenced their destructive influence in the railway world, when the mercantile world suffered calamitous reverses; so intimate are the relations of property. Commercial men, to meet their engagements, sold the railway stock they possessed, times did not mend, the pressure upon the money market increased, and convulsion after convulsion rent and shook the delicate fabric of commercial credit. The huge structure at last gave way, and in its crash seemed to involve all in one common ruin. The bitter storm blew round the world; for England's stability is the keystone in the arch of commerce, and that touched and shaken, quickly spread a baneful influence over every colonial market, and, indeed, more or less over every market in the known world.

"We now approach a greater event, which is perhaps the *greatest crisis* in this world's history. I speak of the great political earthquake, 'so mighty and so great,' which occurred in Paris in February, 1848, and which rapidly vibrated through the length and breadth of Christendom, shattering governments, extinguishing thrones, exiling monarchs, banishing ministers, paralysing commerce, destroying the value of all property, and leaving Europe flooded with the turbulent waters of democracy. From utter destruction by lawless rebellion her armies have rescued her, and she is now slowly emerging; but years must roll on, ere well-organised constituted authority, duly obeyed, can replace her in the position from whence she has retrograded by the revolutionary movements of her people."

The iron trade was of course affected in common with all other manufactures, and the average price of railway iron in Wales was—

	£	s.	d.
In 1849 - - - - - - -	5	4	6
„ 1850 - - - - - - -	5	0	8
„ 1851 - - - - - - -	5	11	7
„ 1852 - - - - - - -	6	0	1

making an average for ten years (from 1843 to 1852) of 7*l.* 2*s.* 6*d.* per ton. The price of bar-iron began to rise in April, 1844, at which period it rose to 5*l.* 10*s.* in Liverpool, and averaged during the remainder of the year 5*l.* 12*s.* per ton.

In January, 1845, it was 6*l.* 10*s.*; in March, 10*l.*; in April, 9*l.*, and averaged for the remainder of the year 8*l.* 10*s.*

	£	s.	d.	
In 1846 and 1847 it averaged - - - - -	9	2	6	per ton.
„ 1848 it commenced at 8*l.*, and gradually fell to 5*l.* 5*s.*, making during the year an average of	6	11	8	„
„ 1849 - - - - - - - - -	5	16	3	„
„ 1850 - - - - - - - - -	5	2	3	„
„ 1851 - - - - - - - - -	5	0	0	„

In 1852, the price in January was 4*l.* 17*s.* 6*d.*, at which it continued, with little variation, till June, when it began gradually to rise, till in October it had risen to 7*l.*, and in December to 8*l.* 5*s.* During the whole of 1853 it continued without any material variation, the average being 8*l.* 10*s.* per ton.

The increase of prices during the last two years is considerable as compared with the prices of former years, and would naturally lead to the conclusion that it was highly remunerative to the ironmaster; but not so, although to some extent beneficial. With the rise in price comes the immediate demand of the men for an advance of wages, and to give an idea of the full extent of what that means as regarding an effect on cost of production, it is necessary to understand that with the exception of the *royalty*, or rent paid to the coal and ironstone proprietors, and certain stores used in the works, *iron is altogether labour.* Colliers, miners, limestone getters, furnacemen of different descriptions, refiners, puddlers, forge and mill men, *all labour;* therefore a rise is occasionally a loss, at

any rate for a time, and the trade requires a larger amount of money for working capital. Where a shop forms part of the establishment, the proprietors receive some considerable assistance from the credit they get on the purchase of the goods, and in some instances, no doubt, these appendages to the works alone represent the item profit. It will be useless to trace the working of cost upon production during a period of years. The price at the present time is sufficiently high to aid a general exposition, and the facts are so recent as to be within knowledge.*

At the quarterly meetings of the Staffordshire and Shropshire ironmasters at Birmingham and the neighbouring towns of Wolverhampton and Dudley, in April, 1854, it was admitted by the leading firms, "*that existing rates are not more than moderately remunerative*, and that the present state of the iron market, under ordinary circumstances, might justify an advance; but the peculiarity of the crisis, and more especially the tight state of the money market, which is likely to have the effect of suspending some important works in the construction of which iron is a principal article of consumption, induced the principal houses of the district to think that it would ultimately be more conducive to the interests of the trade and of the public, if *well* was let alone, and present prices maintained."

* The following extract is from a letter from a friend in France, an extensive iron manufacturer and most intelligent person:—

"A material change has taken place in the relative positions of the iron trade in France and England during the last five or six years. The increased number of works, and the improved modes of working, with the moderate wages paid in France, have tended to render French iron cheaper, and now that wages, and the price of coal and ironstone in England, are so high, and with a brisk demand for iron, we find ourselves able to manufacture iron in France nearly as cheap as we could get it from England, even if the duty were taken off. At our forge we roll from ten to twelve tons of boiler plates *per diem*, of superior quality, as they are principally made from scrap; and these plates do not cost us more than 15*l.* to 16*l.* per ton: at present English prices we certainly could not import them for less, independent of duty. It has been my opinion for some time past, that *strikes* (for wages) would deprive England of much of her foreign trade in iron; *for in all parts of the world the materials for making it are to be found, and we are more economical in the use of our fuel, a thing but little attended to in England.*" (June, 1854.)

It was resolved, therefore, that the prices should remain the same as those fixed in January:—

Bars, 10*l.* Hoops, 11*l.* Sheets, 12*l.* per ton.

There was a decided tendency to a rise in pig-iron, and the *general scarcity of ironstone* was a subject of remark. "It is conspicuous to any one who will cursorily examine the mine returns, that there is a dearth of ironstone. It is difficult to predict, even among those who are deeply interested in the iron manufacture, what under ruling circumstances will be the end of this state of things. There is not only an unabated but an increasing demand for iron, and the supply of almost all descriptions of materials is not equal to the quantities required."

Another writer observes, "The chief difficulty with which our manufacturers have to contend, seems to be the unusual rates they are compelled to give for their pig-iron. This is dependent upon their present scarcity and the high cost of materials, and must be struggled against according to individual resources, until some better supplies of coal and ironstone can be made available."

At this time there were in Staffordshire 123 furnaces in blast, which should produce 12,300 tons weekly, but, on account of the scarcity of ore, they fell far short of that make. "The manufacturers of malleable iron, who a short time ago would scarcely look at *cinder* pigs, are glad under existing circumstances to purchase them, or their works must stand. Great complaints are being made by the owners of mills and forges, as to the price of pigs; the makers of them are obtaining almost any price they please, irrespective of the relative value of manufactured iron. This would appear to give at any rate a large profit to the owners of furnaces, but not so. *The pig-masters are equally submissive to the mine-owners, from whom the ore is obtained, on account of the unusual scarcity of ironstone.*"

"This scarcity of ironstone, and the number of orders on hand for manufactured iron, naturally suggest that, in the course of a short time, *unless relieved by Northamptonshire ore, or by the arrival of materials from other parts of the kingdom,*

the greatest difficulty will be experienced in carrying on efficiently the demands which pour into Staffordshire, not only for Liverpool shipments, but also for home consumption. The price of good ironstone (blue flats) was 22*s.* per ton; the price of pig-iron from 5*l.* 10*s.* to 6*l.* per ton."

Take a moderate rate of materials to make a ton of pig-iron: ironstone, 3 tons at 22*s.* per ton; coal, 4 tons at 10*s.* per ton; add to this, limestone, labour, and charges for stores and management, and it is easy to see that the selling price can be but *barely remunerative.*

If inferior materials are used, a larger quantity is required, but a more important consideration arises out of the scarcity of ironstone. The great superiority of our iron manufacture has generally been considered (independently of the excellent quality of the coal) to consist in having all the materials necessary to the manufacture found on, or immediately in the neighbourhood of, the very spot where the furnaces are erected. *South Staffordshire as it was,* will serve to illustrate this point—abundance of good coal—amongst other seams that of the ten-yard—excellent ironstone and limestone; this last from Dudley, celebrated for its beautiful fossil slabs; but now limestone is brought from the Vale of Llangollen, and the ironmasters are looking to Northamptonshire and other places to assist them with the required supply of ironstone. Is not this, as regards South Staffordshire, the *beginning of an end?*

This scarcity of materials is certainly most beneficial to districts where, from the want of coal, it was never contemplated having any share in the manufacture of iron; but it alters the general character of the circumstances under which we have been accustomed to view our superiority, and casts the first shadow upon the iron trade. But thanks to our railways and canals, the intimate connection of all parts of the country may still enable England to maintain its most valuable and important position amongst foreign nations, as the great emporium of the iron manufacture.*

* Since writing the above, Mr. Blackwell has kindly presented to the author a copy of his valuable lecture on *The Iron-making Resources of the United Kingdom,* it being one of a series of Lectures on the Results of the Exhibition,

The following particulars of the make of 1852 are taken from Mr. Braithwaite Poole's statistics of commerce: —

Districts.	Furnaces.			Tons. Pig-iron.
	In.	Out.	Total.	
Scotland - - - -	113	31	144	775,000
South Wales - - -	135	27	162	635,000
Ditto, Anthracite - - -	12	23	35	31,000
South Staffordshire - -	127	32	159	725,000
North Staffordshire - -	17	4	21	90,000
North Wales - - -	6	7	13	30,000
Shropshire - - - -	27	13	40	120,000
Durham - - - -	18	8	26	110,000
Northumberland - - -	7	6	13	35,000
Yorkshire and Derbyshire -	35	7	42	150,000
Total - - -	497	158	655	2,701,000

Having traced the history of the manufacture of iron, it now becomes necessary to consider through what channels it

delivered before the Society of Arts, Manufactures, and Commerce, at the suggestion of H.R.H. Prince Albert, President of the Society.

The following are extracts from this lecture; for particulars, the book itself must be referred to. The extracts refer almost entirely to the principal available ironstones and ores:—

"Coal-measure Ironstones.—These are, the argillaceous ironstones, and the black-band or carbonaceous ironstones.

"They are entitled to the first place, as they supply at least nine-tenths of the iron produced.

"Of the first class, the number of separate measures contained in some of our coal fields is very great, and the variety of character they possess is almost as great. (They required 400 specimens to illustrate them at the Exhibition, and were not, even then, complete.)

"Black-band Ironstones.—The localities where this peculiar class of ironstones exist are, as at present known, the following:—Scotland, Northumberland, North and South Wales, North Staffordshire, locally in some parts of the South Staffordshire field, north of Wolverhampton, and the Clee Hills. Of these, Scotland and North Staffordshire are the best known, and by far the most important,

"Red Hæmatites.—The most important deposits of these ores are those of Lancashire, Cumberland, and the Forest of Dean. This last is not rich as a class, but, from the great masses in which it is found, its cost of production is very low, the supply unlimited. The hæmatites of Whitehaven and the

is principally consumed, and in thus tracing it to show the extent to which the cheap and abundant supply of this metal

Ulverstone and Furness districts are raised most extensively for shipment to the iron-works of Yorkshire, Staffordshire, and South Wales. These ores yield from 60 to 65 per cent. In quality they may be considered as the finest in the kingdom, and the supplies which those districts are calculated to produce are very great.

"In 'Poole's Statistics of Commerce,' the following are given as the quantities of hæmatite estimated to have been raised from the different mines at work in 1851 :—

Mines.		Tons.
17	Ulverstone and Furness	182,000
13	Whitehaven	100,000
8	Forest of Dean	95,000
17	Cornwall, Somerset, and Devon	118,000
2	Isle of Man	2,500
1	Ireland	1,500
2	Scotland	1,000
60	Mines, producing	Tons 500,000

"Oolitic Ironstones.—We now come to another class of ores, of great importance; a class, the discovery of which marks a new epoch in the history of the iron trade, and which is of twofold interest, from the fact that our knowledge of the existence of these deposits of iron has occurred simultaneously with the development of the facilities of transport now afforded by our railway system, and without which this class of ores would have been comparatively worthless. Thus, the iron trade, after giving birth to the wonderful results of modern science and industry, finds itself fostered and extended in its bounds by its own offspring, and a new era opened out to it by its own internal and self-sustaining power.

"These deposits of ore are found occupying a position at the base of the oolitic formation, which, commencing on the east coasts of our island, from the south bank of the River Tees to Scarborough, stretches in a line, more or less interrupted, through the midland counties of Yorkshire, Lincolnshire, Rutlandshire, Northamptonshire, Oxfordshire, and Dorsetshire, down to the south coast, between Lyme Regis and Dorchester, where being turned aside by the granite formations of Devon, it is prolonged into France.

"The iron ore of this formation was first known and worked at its very northern extremity, in the neighbourhood of Middlesborough. Here, some two or three years ago, a workman noticed a considerable deposit of iron, which took place from a spring issuing at the base of one of its beds. Upon calcining a piece of the rock, its character was at once evident; he communicated his discovery to the proprietors of the extensive iron-works of Witton Park and Middlesborough, who immediately recognised its importance, as the bed, upon examination, proved to be 15 feet in the points of out-crop, and to contain 30 per cent. of iron.

"Lying at the summit of the Cleveland Hills, in many places with only a thin covering of soil, it could be raised at a cost even less than that of the celebrated black-bands of Scotland and North Staffordshire. Its cost, indeed, resolved itself more into the question of transport. The railways of the district

has so materially contributed, in extending our commerce and the interests of the country in general. Railways have for some years been the principal consumers, and their formation may so far be considered as making iron *reproductive;* as they enable the ironmasters to get those supplies of ironstones and ores which, as we have already shown, are in some measure now, and to a greater extent hereafter may be, essential to the support of the manufacture in particular districts, bringing them from parts of the country where, but for this assistance, they would have been utterly useless, except occasionally as

already laid down for its important coal trade, supplied these means, and branches were speedily made to the Cleveland Hills themselves. But for this discovery, some of the principal iron-works of the North of England must have been closed, as the cheap black-bands of Scotland had destroyed the present value of the comparatively expensive argillaceous ironstones of the Newcastle coal fields, which, consequently, could be no longer used. In addition to the supply of existing works, the almost inexhaustible supply within reach led to the erection of iron furnaces at Middlesborough, where three furnaces are already in blast, working almost exclusively from this ore, and others are in process of erection.

"An investigation, at the close of the Exhibition, was rewarded by the discovery, at Higham Ferrers, of a bed of ore many feet in thickness. This led to further examination, and to the discovery of the Northamptonshire deposits, which have latterly attracted so much attention, and which are already becoming extensively worked. It appears to be developed most largely, and to be also of best quality, along the Northampton and Peterborough line of railway, from Higham Ferrers to Hardingstone, near Northampton; and again from Gayton, near Blisworth, to Towcester.

"Its knowledge comes to us at a most opportune moment, to afford to the important South Staffordshire[1] district cheap supplies of ironstone, for the purpose of admixture with its own argillaceous stones. Hitherto the second most important iron district in the kingdom, it could no longer have maintained its ground against other localities, had it not been for this discovery. South Wales had its cheap and good coals, its black-bands, and its supplies of sea-borne hæmatites, as well as its own argillaceous ironstones; Scotland, its beds of black-bands; and the North of England its oolitic ores: but, up to the present time, South Staffordshire had only its argillaceous ironstones, always the most expensive to raise, with such admixture of hæmatite and North Staffordshire stone as the great cost of carriage would permit. Now the Northamptonshire oolites will add to its supplies, and make it to hold its place amongst the other competing districts.

"Any survey of the general iron-making resources of the kingdom would be most incomplete which did not include our different coal-fields, not simply as productive of vast supplies of iron in their argillaceous and black-band

[1] From inquiries made by the writer, it does not appear that this ironstone is in favour with the South Staffordshire ironmasters; on the contrary, many have given up the use of it.

building materials. Railways have already been mentioned; but at one view, to give an idea of the enormous extent and bearings of these undertakings *in this country alone* (for the iron for railways throughout the world is supplied by Great Britain), we will draw attention to the following statement:—

Mr. Cardwell, the President of the Board of Trade, in

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ironstones, but also as furnishing that class of fuel now almost exclusively employed for smelting purposes.

"AREAS OF COAL FIELDS.

Northumberland and Durham	840	square miles.
Cumberland (West)	96	"
Yorkshire, Derbyshire, &c.	964	"
Lancashire	308	"
Cheshire	90	"
North Wales	160	"
Shropshire	75	"
Staffordshire	302	"
Warwickshire	105	"
Forest of Dean	35	"
Gloucestershire and Somersetshire	48	"
South Wales	1,045	"
	4,068	"
Scotland	1,700	"
Total	5,768	square miles.

"Of these, several — as, for instance, Northumberland and Durham, Lancashire, Gloucestershire, and Somersetshire — do not contain, in their coal measures, any important supplies of ironstone, and are therefore only connected with our iron manufacture by means of their beds of coal."

By parliamentary returns, it appears that in the year 1851, the following quantities of coal, cinder, and culm, were exported from the United Kingdom to foreign countries, and to the British settlements abroad: also, in the same year, the quantity of coal conveyed to London:—

			Tons.
		Coal	3,300,257
		Cinders	166,353
		Culm	1,935
			3,468,545 [1]
Coastways to London		3,508,656 [2]	
By canal	24,206		
By railway	247,908		
		272,114	
			3,780,770
		Tons	7,249,315

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[1] Declared value, £1,302,473.

[2] Number of vessels employed, 11,765.

moving, on the 6th April, 1854, for leave to bring in a Bill for the better regulation of the traffic upon railways and canals, stated, that there had been 232 companies incorporated. The number of miles authorized to be constructed was 12,700, of which 7,686 miles were opened. The number of passengers by the last return was 95,000,000; the number of persons employed in their transit, 80,000; the amount of capital authorized was 350,000,000*l.*, and the amount actually raised was 264,000,000*l.*; the last year's return of traffic being 16,700,000*l.**

* By the Census of the United States, it appears that, on the 1st January, 1852, the extent of railroads completed and in operation was 10,843 miles, and the number of miles in course of construction, 10,898 miles; making a total of 21,741 miles—on the 1st January, 1853, there were in operation 13,266 miles, and in course of construction 12,681 miles; together 25,947 miles.

	Dollars.
Cost of completed railroads 1 Jan. 1852 -	372,770,000
Estimated cost of those in progress - -	220,000,000
Total invested in railroads - -	592,770,000

The average cost per mile of the works completed on the 1st January, 1852, 34,370 dollars.

"For the purpose of comparison with the foregoing, the subjoined statement has been prepared, showing the number of miles of railroads, with their costs, according to the most generally received authorities in all countries of Europe in which these improvements have been to any considerable extent produced:—

Countries.	Miles.	Aggregate Cost.	Cost per Mile.
		$	$
Great Britain and Ireland - -	6,890	1,218,000,000	177,000
German States, including Prussia and Austria - - -	5,332	325,875,000	61,000
France - - - - - -	1,018	238,905,000	254,000
Belgium - - - - - -	532	46,288,000	49,000
Russia - - - - - -	200	15,000,000	75,000
Italy - - - - - - -	170	15,000,000	88,000
	14,142	1,859,068,000	

"This table was made before the opening of the railway from St. Petersburg to Moscow, which, being nearly 400 miles in length, would add largely to

The next and more enduringly important consumer is the shipping interest: —

To pass through the Liverpool Docks, which extend for some miles filled with ships, and see the anchors, chain cables, and parts of the rigging, made of iron, and occasionally an iron ship, any one with common observation must be struck with the advantages possessed by this country in having an abundant and cheap supply of this most essential material, and the more so, when not far from these docks lies the Chinese Junk, with its primitive *wooden* anchor. The heavy and almost exclusive duties levied on iron in many foreign countries, gave a great advantage to our ship-building trade, as may be more fully seen in the chapter on the United States of America. The alteration in our corn duties, and in fact the general tariff, assisted by the desire to procure rails, has occasioned some reduction, which, aided by the large make, and at the same time depressed prices, has enabled them to receive our iron in large quantities, and in some degree placed foreigners upon a more equal footing with ourselves; but we still bear the palm.

By a parliamentary return of 1852, relating to the increase and extent of our shipping, it appears that there were in 1814 24,418 vessels belonging to the British Empire, the tonnage 2,616,965, and employing 172,786 men; in 1851 the ships had increased to 34,244, amounting to 4,332,085 tons, and giving employment to 240,928 men.

In the same year 1851, there were 88 steam-vessels built and registered — together 23,527 tons.

The total number of steam-vessels belonging to the British Empire, 1,386, tonnage 204,654.

The number of vessels built and registered in the British Empire, from the year ending the 5th January, 1815, to the 5th January, 1851, a period of 36 years, was 49,254, tonnage, 6,388,864, making an annual average of 1368 vessels;

these statistics so far as refers to Russia. In France also, during the past season, 1,500 miles of railway, in addition to that stated in the table, were opened, making the whole extent of railway in that country in July last (1852) about 2,500 miles; and it is expected that, during the course of the ensuing year, 1800 miles additional will be completed."

and this may be taken as a fair average. There was a falling off in 1815, and from 1821 to 1824, which was made up by a corresponding increase in 1827, and from 1839 to 1842.

With regard to the iron required for these vessels, we have in the first place *anchors.* Dr. Ure says, "The weight of anchors for different vessels is proportioned to the tonnage; a good rule being to make the anchor in hundredweights one-twentieth of the number of tons of the burden; thus a ship of 1,000 tons would require a sheet anchor of 50 cwts. Ships of war are provided with somewhat heavier anchors."

Chain Cables.—These require, and will admit of a more extended notice.

The application of strong iron chains or cables to the purposes of navigation, is a late and an important discovery. It is singular, indeed, that this application should not have been made at a much earlier period. On rocky bottoms, or where coral is abundant, a hempen cable speedily chafes, and is often quite destroyed in a few months, or perhaps days. A striking instance of this occurred in the voyage of discovery under the orders of M. Bougainville, who lost *six* anchors in the space of nine days, and narrowly escaped shipwreck; a result, says that able seaman, which would not have happened "*si nous eussions été munis des quelques chaines de fer. C'est une précaution que ne doivents jamais oublier tous les navigateurs destinés à de pareils voyages.*" The work from which this extract is taken ("Voyage autour du Monde") was published in 1771; and yet it was not till nearly *forty* years after that any attempt was made practically to profit by so judicious a suggestion. The difficulties in the way of importing hemp from the year 1808 to the year 1814, and its consequent high price, gave the first great stimulus to the manufacture of iron cables.

The first avowed proposal to substitute iron cables for cordage in the sea-service was made by Mr. Slater, surgeon, of the navy, who obtained a patent for the plan in 1808, though he does not seem to have had the means of carrying it into effect. It was Captain Brown of the West India merchant service who, in 1811, first employed chain cables

in the vessel Penelope of 400 tons burden, of which he was captain. He made a voyage in this ship from England to Martinique and Guadaloupe, and home again, in four months, having anchored many times in every variety of ground without any accident. He multiplied his trials, and acquired certain proof that iron might be substituted for hemp in making cables not only for mooring vessels, but for the standing rigging. Since this period chain cables have been universally introduced into all the ships of the Royal Navy, as well as into the merchant ships; but the twisted links first employed have been replaced by the straight ones stayed in the middle with a *cross rod*, the contrivance of Mr. Brunton. Repeated experiments have proved that his cables possess double the strength of the iron rods with which they are made. As there are many emergencies in which the cable must be severed, this is accomplished in those of iron by means of a bolt and shackle at every fathom or two fathoms; so that by striking out this bolt or pin, the cable is parted with more ease than a hempen one can be cut.

Vessels furnished with such cables have been saved from the most imminent peril. The *Henry*, sent out with army stores during the Peninsular War, was caught on the northern coast of Spain in a furious storm; she ran for shelter into the Bay of Biscay, among the rocks, where she was exposed three days to the hurricane. She possessed, fortunately, one of Brunton's 70 fathom chain cables, which held good all the time; but it was found afterwards to have had the links of its lower portion polished bright by attrition against the rocky bottom. A hemp cable would have been speedily torn to pieces in such a predicament.

While speaking of the appendages of ships, we may observe that the lower masts of that ill-fated vessel, the *Tayleur*, were iron; and a notice has just appeared that "a new invention has been introduced at Liverpool by the patentee, Mr. Clare, consisting of metallic masts and yards for vessels of all descriptions. They are made of wrought iron, cased with wood, and are alleged, apparently on good authority, to be lighter, stronger, and more durable than

the ordinary wooden ones, while the first cost is the same in both cases."*

Mr. John Grantham, C.E., in a work published by him in 1842, on "Iron as a Material for Ship-building," says that the first construction of iron vessels is by no means of so late a date as is generally supposed; iron boats for navigating canals having been built so long back as forty years. The first iron steamer that ever put to sea, the *Aaron Manby*, was constructed at the Horsley Iron-works, under the direction of Mr. Manby, the projector, who was assisted by Captain (now Admiral Sir Charles) Napier, on whom the hopes of Great Britain are fixed to bring to a speedy conclusion the Russian aggressive war. The *Aaron Manby* was sent to London in parts, and put together in dock; and Captain Napier having charge of her, navigated her direct to Havre, and thence to Paris, without unloading any part of the cargo (consisting of linseed and iron-castings); she being the *first and only* vessel of any description that ever went direct from London to Paris.

The second iron vessel was also built by the Horsley Company. She was put together in Liverpool in 1825, and crossed the Channel, proceeding to her destination, Lough Derg, on the River Shannon, where for many years she was constantly at work. Iron vessels have of late come into very general use. The first iron sailing vessel of any magnitude employed in sea-voyages was the *Ironside*.†

* *The Times*, 6th April, 1854.

† *Comparative Cost of Wooden and Iron-built Ships.*—Liverpool, 23rd February, 1854.—In a recently-issued circular by Mr. James Hodgson, consulting engineer, of Liverpool, we find the following comparative annual cost of the working of a wooden and iron ship of 1,000 tons each:—"Suppose a wooden ship of 1,000 tons to cost 16,500*l.*, or 16*l.* 10*s.* per ton; then suppose an iron ship to cost 13,500*l.*, or 13*l.* 10*s.* per ton, both fitted for the East, we have the following result:—Wood—16,500*l.* at 3 per cent. for insurance, 495*l.*; ditto, at 5 per cent. for depreciation, 825*l.*; ditto, at 5 per cent. for interest, 825*l.* = 2,145*l.* Iron—13,500*l.* at 3 per cent. for insurance, 405*l.*; ditto, at 2 per cent. for depreciation, 270*l.*; ditto, at 5 per cent. for interest, 675*l.* = 1,350*l.* Difference in favour of iron, 795*l.* A wooden ship of 1,000 tons trading to the East will not carry more than 1,500 tons, which, at 5*l.* per ton, for the voyage out and home, will give 7,500*l.*, while an iron ship of 1,000 tons, built from the same external lines, will carry 1,800 tons, which, at 5*l.* per ton, will give 9,000*l.*; making a total in favour of an iron ship of 1,000 tons of 2,295*l.*

In the *Morning Chronicle* of 13th November, 1844, it is stated, "Some curiosity has been excited by the arrival in the Thames of a Newcastle collier, a fine-looking vessel, built of iron, and fitted with a screw propeller, working an engine of 20-horse power."

But the vessel which has generally attracted the most attention in Liverpool is the *Great Britain* iron screw steamer. She was built at Bristol, although a Bristol man might have some difficulty in proving her identity. When built, it was found that the dock entrance was not wide enough to let her out, and it had to be altered accordingly. On her voyage to America, she was run aground on the Irish coast, and after lying there for many months, was at length got off and brought into Liverpool, presenting a most deplorable appearance. Having been thoroughly repaired, she is now employed in the Australian trade; and the arrival or departure of this noble ship is always a matter of great interest —more so by far than that of any other vessel which enters or leaves this port.* There is still one subject, and that a

* Since the *Great Britain* left Liverpool on her present voyage she has had some formidable rivals, namely: —

The *Himalaya*, an iron screw-steamer, 3,500 tons, purchased by government for the conveyance of troops to the East. This magnificent vessel was built by Mr. Mare, of London, for the Peninsular and Oriental Steam Navigation Company. She cost 153,000*l.*

But Liverpool people will take still more interest in the *Nubia*, an iron screw-steamer of 2,200 tons, 315 feet in length.

This beautiful vessel was built by Mr. John Laird, of Birkenhead, a gentleman who took an early interest in iron ships. The engines, of 450 horse-power, on the oscillating principle, were made by Messrs. Fawcett, Preston, and Co., of Liverpool. The author was fortunate enough to accompany his friend Captain Henry Harris, who commands the *Nubia*, to Southampton. Captain Harris formerly commanded the *Lowther Castle*, in the Hon. East India Company's service. He navigated the *Precursor* steamer rounded the Cape, and was one of the first to open the mail line by the Red Sea. The *Nubia* arrived at the *Needles* with the utmost ease in 45 hours, although there was a very strong head wind against her till she passed Holyhead. The machinery worked without noise, and with scarcely any perceptible vibration. The compasses were adjusted with the most perfect accuracy, no trifling matter in an iron ship. *Surely this is a near approach to perfection in steam navigation!*

She was built for the Peninsular and Oriental Steam Navigation Company, and sails early in September with the mails for Alexandria.

Mr. Laird has lately (July, 1854) launched the *Pera*, an iron screw-steamer, of the same size as the *Nubia*, and for the same company.

most important one, as connected with steam navigation, relating to this vessel; and that is the fuel used in her last voyage to Australia, the owners having ventured mainly on the use of anthracite, with most successful results.

It appears that during her first voyage to Australia in 1852 the consumption of coal from various causes was 50, 55, and even 60 cwt. per hour, with all boilers at work; under the same circumstances, in this last voyage she consumed from 28 to 33 cwt. per hour of anthracite, and her furnaces had been somewhat shortened. It was, however, very rarely that she was under more than half her boilers—that is, *three* — and it was found that with these, and a consumption of 15 to 16 cwt. of anthracite per hour, or 18 to 20 tons per day, she could obtain a regular steam speed of 7⅓ knots; whilst with all boilers at work, and a double consumption of coal, she could not average above nine knots; so costly, to a vessel of her size, is the gain of the increased speed.

It is generally understood that the intense local heat of this coal is so destructive to the boilers and the bars of the furnace, that it is impossible to use it; but it is stated that the boilers were in no degree affected by it, and of the whole complement of bars, only four were touched by fire, the set having their edges as sharp as if only a short time in use.

The *steamjets,* as recommended by Professor Frankland, and as applied by Colonel Coffin to her Majesty's yacht, were used in the *Great Britain* with beneficial effect.

"She goes out again with the same fuel, she takes less than before, gains space for her cargo, touches nowhere, saving time in recoaling, and confidently anticipates making the voyage in 60 days."

The great difficulty in using the anthracite, or stone-coal, is the intense heat acting on those parts where it is placed, and from want of flame not distributing heat generally on the boiler, as in the case of the common bituminous coal; but if it can be made available, how valuable a fuel it would be, especially in long voyages! The writer, therefore, having some years back had some experience in the use of this coal, may be excused for giving the result of his observations. It was about

the year 1830, when many experiments were made in London for the consumption of smoke, and amongst other schemes the anthracite, then extensively used in malting, was recommended for trial to one of the principal breweries, as a fuel without smoke, which, if it could be made available, would answer every required purpose. It was tried in various ways, but the best was found to be *by breaking the coal into pieces about the size of a cocoa-nut in the inner shell, thus presenting as many angles as possible to the action of the fire.* There was some difficulty at first in getting up the steam quickly, but this was overcome by mixing a portion of free-burning coal with the anthracite on lighting the fire. It was then used extensively till a coal called the Llanelly came into use, which combining the essentials of free-burning, and of being free from smoke, it took the place of the anthracite.

By breaking the coal, and by passing *a jet of steam*, which can be easily done, into the furnace of the engine, it can be made available to the purposes of steam navigation.

It will not be necessary to notice at any length the various channels of consumption of our iron manufacture. We have the tubular bridges; boilers for steam-engines; tanks similar to those used for floating the landing-stage at Liverpool, and the connecting iron bridges; water-pipes, of which those now casting at Glasgow, of about four feet in diameter, to convey the water from Rivington Pikes for the supply of Liverpool, may be particularly noticed—(Mr. Braithwaite Poole, in his "Statistics of Commerce, 1853," states the consumption of pig-iron in Glasgow and its neighbourhood at 200,000 tons a year); also, gas-pipes. These are general throughout the country, and convey a source of light, which is not one of the least of the wonderful improvements of the last half-century. The writer perfectly remembers an experiment of filling the bowl of a tobacco pipe with small coal and covering it with clay, then placing it in the fire, and when the gas began to escape, lighting it, and being told that there was a person (Mr. Windsor) who actually believed that the day would come when he should be able to light a town with gas

produced upon the same principle. Lord Dungannon, the father of the well-known Lord Cochrane, first used it to light his house.

Then we have iron in buildings of every description; and in fact it is used for every purpose for which it can in any way be made available.

In a notice of the former edition of this work in 1841, the application of iron is very graphically described:—

"In every part of the globe where the application of iron to beneficial purposes is understood, its importance cannot but be highly appreciated; but in England it has long been the great sinew of her strength and prosperity. By her superiority in mechanical skill in the use of this metal, her commerce and her arms have made her name famous in almost every part of the habitable world. The universality of the employment of iron is so manifest, especially in this country, that if any period has deserved the title of the Iron Age, to none can it be applied so characteristically as to the present. The seas are traversed by iron ships, the land travelled over by iron carriages upon iron roads; we have iron engines employed for nearly every mechanical purpose. Water is brought along our streets by iron pipes, and all our thoroughfares illumined by means of gas conveyed to us through a similar channel. Many of our houses have iron floors and iron roofs, whilst the windows are closed with iron shutters. In short, from the gigantic steamer that crosses the Atlantic, to the smallest of ornamental shirt-buttons, this metal has become so prevalent, that the island ought to be ticketed, like a laundress's window, with 'Ironing done here.' But the wealth and comfort arising from this state, makes it equivalent to the much more lauded advantages of the Golden Age." *

Ten years after this was achieved the great master-piece of art, the Crystal Palace. †

* *New Monthly Magazine*, Thomas Hood, October, 1841.

† Since then, similar buildings have been erected, the principal being the Sydenham Palace, opened in 1854. The entire length is 1,608 feet; the length

Mr. Blackwell in his lecture says, "However successful we may regard the Exhibition of 1851 for the great purpose for which it was originally designed—namely, to illustrate the progress made up to the present time in the various departments of the arts and manufactures of the world, and however wonderful may have been the vast collection of objects of wealth and industry which the science and skill of modern civilisation then brought together, it may certainly be asserted that the Exhibition itself displayed in no one of its details any more remarkable instance of modern progress than the vast and stately building which rose, with almost magic rapidity, from the ground, and which was no less admirable for its beauty and simplicity than for its amazing vastness, and its perfect adaptation to the purposes for which it was designed. The very conception of the idea of the Crystal Palace and its successful execution, placed prominently before us the great iron-making resources of the kingdom, and the extraordinary degree of perfection to which some of the branches of our iron manufacture have attained. Whilst the other manufactures of the kingdom were illustrated by a careful selection of the most perfect results, attained in their own separate departments, the most remarkable illustration of the present condition of the iron manufacture was to be found in the building itself, which spread its lofty roof and walls of light over all it held, and guarded with such perfect care and fitness the boundless stores of wealth collected together from so many parts of the world."

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of centre transept, 408 feet; length of end transepts, 312 feet; the width of nave is 72 feet; the width of centre transept, 120 feet; the width of end transepts, 72 feet; and the projection of the bays is 8 feet. These dimensions, it will be seen, are all multiples, or parts, of 24 feet, the distance from column to column throughout. The height of the first story, including the girder, which is 3 feet, is 22 feet; the height of the second story (including girder), third story, fourth story in centre transept, and fifth story in transept, 20 feet in each case. The ribs of the roof spring at 8 feet above the upper galleries in nave and transepts. The height from the floor to the centre of the roof of the nave, and of end transepts, is 106 feet; and the height from the floor to the centre of the roof of the centre transept, 170 feet. The diameter of the octagon column is 7½ inches.—*The Builder.*

It only now remains to speak of the exports of iron,* which have much more than increased in proportion with the make. The export in 1839, which is the last return noticed in the former edition of this work, was 269,088 tons, the make being 1,300,000 tons. In 1852 the export was 1,035,884 tons, the make being 2,700,000 tons. The make is calculated in pigs. The exports are for the far greater proportion in manufactured iron, thus:—In 1839, of the 269,088 tons exported, 54,296 tons were pig and cast-iron; and in 1852, of the 1,035,884 tons, 302,356 tons were pig and cast-iron. To give, therefore, a clearer idea of the extent of exports as compared with make, one-third may be added to the manufactured iron as waste in conversion. This would make the exports in 1839, 340,685 tons, and in 1852, 1,280,393 tons.

The increase of exports to most of the continental states is very considerable; this arises in a great measure from the demand for railway iron. But the United States of America are in every respect (except as regards machinery and mill-work) our principal and most important customers. The export to the United States in 1839, was 85,172 tons; in 1852, it was 501,158 tons; and of hardware and cutlery in 1852, out of a declared value of 2,691,697*l.*, they took 968,492*l.*

The exports to our own colonies throughout the world at the same period being—Of iron in 1839, 60,417 tons; in 1852, 141,460 tons; and of hardware and cutlery, 554,994*l.* With respect to the machinery and mill-work, the United States do but little; out of an export in 1851 of a declared value of 1,168,611*l.*, they took but 31,426*l.*, a clear proof of their own proficiency. Of this description of export, Russia is the principal purchaser:—

* The author had an intention of entering into the particulars of the shipments of iron from Liverpool, but as this information would principally interest the merchants and other residents, it has been thought better to give the total of shipments from all ports, as of more general use; besides, another and an important consideration influenced this decision:—Mr. Baines, in his "History of Liverpool" (a work already referred to), has treated so fully on all matters relating to the trade of this town, that all those who are particularly interested must be familiar with the subject.

From 1840 to 1844, the average taken by Russia was	£74,331
1845 — 1849 „	168,499
1850	203,991
1851	216,052

EXPORTS OF BRITISH IRON, INCLUDING UNWROUGHT STEEL.

Years.	Tons.
1840 to 1844, average	381,254
1845 — 1849 „	534,120
1850	783,482
1851	919,479
1852	1,035,884

DECLARED VALUE OF THE EXPORTS OF BRITISH IRON AND STEEL.

Years.	Tons.
1840 to 1844, average	2,725,543
1845 — 1849 „	4,531,760
1850	5,297,901

EXPORTS OF BRITISH HARDWARE AND CUTLERY.

Years.	Tons.	Declared Value.
1840 to 1844, average	17,522	£1,659,238
1845 — 1849 „	20,502	2,153,406
1850	25,746	2,641,432
1851	27,624	2,827,011
1852	25,289	2,691,697

EXPORTS OF MACHINERY AND MILL-WORK.

Years.	Declared Value.
1840 to 1844, average	£637,761
1845 — 1849 „	960,746
1850	1,042,166
1851	1,168,611

FOREIGN BAR-IRON IMPORTED.

Years.	Tons.
1840 to 1844, average	19,738
1845* — 1849 „	30,923
1850	34,065
1851	40,279
1852	33,375

* In 1845, the duty of 20*s.* per ton was taken off foreign iron.

FOREIGN BAR-IRON EXPORTED.

Years.	Tons.
1840 to 1844, average - - -	4,248
1845 — 1849 „ - - - -	4,035
1850 - - - - - -	5,996
1851 - - - - - -	4,812
1852 - - - - - -	5,773

BRITISH IRON EXPORTED, INCLUDING UNWROUGHT STEEL, IN THE YEARS 1839, 1851, AND 1852,

And Declared Value of British Hardware and Cutlery, and Machinery and Mill-work, exported in the year 1851.

Countries to which exported.	Iron exported.			Hardware and Cutlery.	Machinery and Mill-work.
	1839.	1851.	1852.	1851.	
	Tons.	Tons.	Tons.	£	£
BRITISH COLONIES.					
North America - -	21,547	90,933	85,764	184,086	5,031
Asia (including China) -	27,376	49,009	31,518	113,233	30,881
West Indies - - -	6,626	5,837	7,351	62,050	54,278
Australia - - -	- -	11,462	14,028	139,115	24,007
Africa - - - -	4,868	2,468	2,799	29,395	3,362
Total - - -	60,417	159,709	141,460	527,879	117,559
United States of America	85,172	464,559	501,158	1,080,487	31,426
France - - - -	14,934	14,661	22,325	87,152	77,150
Holland - - -	24,226	40,711	50,398	55,576	37,119
Belgium - - -	2,658	1,651	2,215	39,209	34,199
Spain - - - -	1,244	11,549	27,369	44,445	141,136
Portugal - - -	6,721	11,776	9,498	21,320	13,151
Russia - - - -	952	8,254	8,033	86,044	216,052
Sweden - - - -	238	1,000	1,016	8,220	31,349
Norway - - -	308	7,261	6,739	12,670	16,553
Denmark - - -	6,180	14,718	22,322	14,583	5,247
Prussia - - - -	3,384	33,113	39,430	9,196	23,305
Germany - - -	12,850	41,117	69,457	170,324	153,865
Italy - - - -	19,125	45,830	53,153	66,589	63,270
Turkey, Greece, Egypt -	7,487	14,548	33,448	56,260	19,156
Brazil - - - -	4,582	9,178	11,564	108,406	23,715
Mexico and States of South America - -	5,207	11,067	7,928	183,115	21,724
Other Countries - -	13,403	28,777	28,371	255,536	142,635
Total - - -	269,088	919,479	1,035,884	2,827,011	1,168,611

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THE END.

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